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AIR FLEET

Russian Air Force, aircraft & space review

Su-30MKI
RUSSO-INDIAN PROGRAMME

- RUSSIAN & CIS AIRCRAFT IN INDIA
- ANTONOV AN-140: PILOT'S OPINION
- CARRIER-BORNE FIGHTERS: WHICH TO CHOOSE

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Flight Research Institute

AVIASALON Co
Flight Research Institute,
Zhukovsky, Moscow region, 140182, Russia
Phone: + 7 (095) 556 7786, 556 5265
Fax: + 7 (095) 742 8751, 556 5413
E-mail: maks@pt.comcor.ru

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PUBLISHER

INTERVESTNIK
PUBLISHING HOUSE

PUBLISHER & CEO
Nikolay Laskov
PUBLISHING HOUSE EDITOR-IN-CHIEF
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Nadezhda Kashirina,Vadim Lukyanov,
Vassily Melnikov, Yelizaveta Popova,
Daniil Solovyov
DESIGNERS
Igor Belov, Grigory Butrin, Irina Dynga,
Aleksei Kanunnikov, Denis Polyakov, Vladimir Yakovlev

REGIONAL REPRESENTATIVES
Kuala Lumpur, Malaysia
Maria Kiseleva E-mail: mariakiseleva@hotmail.com
Kiev, Ukraine
Vladimir Skubiy Tel: +38 (044) 238-81-12

AIR FLEET STAFF

EDITOR-IN-CHIEF
Andrei FOMIN E-mail: andrey@airfleet.ru
FIRST DEPUTY EDITOR-IN-CHIEF
Andrei YURGENSON E-mail: au@airfleet.ru
DEPUTY EDITOR-IN-CHIEF (AVIATION)
Nikolay VALUEV E-mail: valuev@airfleet.ru
EDITORS (CIVIL AVIATION)
Alexander PONOMARYOV E-mail: alex@airfleet.ru
Valery AGEYEV E-mail: ageev@airfleet.ru
EDITOR (ROTORCRAFT)
Vadim MIKHEYEV E-mail: helicopter@airfleet.ru
EDITOR (AIR DEFENCE)
Alexei ZAKHAROV E-mail: aaz@airfleet.ru
Pavel IVANOV E-mail: ivanov@airfleet.ru
PHOTO EDITOR
Aleksei MIKHEYEV
CORRECTOR
Vera NISTRATOVA

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ADDRESS:
P.O.Box 77, Moscow, 125057, Russia
Tel.: +7(095)158-33-05, 158-95-01
Fax: +7(095) 956-01-07
E-mail: af@airfleet.ru
http://www.airfleet.ru

Dear reader,

We are pleased to note that for five years Air Fleet has been attracting your attention. Given that Air Fleet is virtually the only specialised English-language magazine dedicated to the issue of the Russian aviation development, we have at all times tried to give a full and all-round account of what's going on in the Russian aerospace industry, the Air Force, civil aviation and cosmonautics.

Despite the fact, that following the break-up of the formerly great aviation power called the USSR Russia became its successor, it is not the only former Soviet republic that can boast significant progress in the domain of aviation industry and an air force equipped with most up-to-date aircraft, that include both Soviet legacy and new Russian-built machines. Take Ukraine that has years of experience in transport and passenger aircraft development and manufacture, aeroengines designing and production, missile construction, as well as repair and upgrade of various types of aircraft. One of the oldest aircraft manufacturers of the former USSR located in Tashkent, the capital city of Uzbekistan, produces modern transport aircraft and passenger airliners. Specialists of the Baranovichi-based aircraft repair plant in Belarus offer quality repair of both combat and civil fixed- and rotary-wing aircraft. The list is endless.

Our magazine has never failed to cover aerospace-related events and processes taking place in CIS nations. However, given the growing tendency for integration among aircraft industries of different countries, former USSR republics being no exception, we plan to give still more attention to the issue, turning Air Fleet into an international Russian-CIS aerospace review. We will also give more attention to employment of our aircraft abroad, as well as ever increasing international cooperation with foreign countries in the realm of aerospace industry.

In 2003 the magazine has become noticeably thicker, this much due to introduction of new columns. But we are not going to stop at that – other improvements and interesting topics are there, waiting for their time. We will continue to provide the interested reader with unbiased and comprehensive information on whatever happens in the sphere of aviation in Russia, CIS and across the world. Hopefully, we will continue to see you among our readers and subscribers!

Best regards and aviation compliments,
Andrei Fomin
Air Fleet Editor-in-Chief

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The Russian High-Tech Development Fund
Tel./fax: +7 (095) 954-8087
E-mail: info@hitechno.ru

Participation of foreign companies
The Moscow Chamber of Commerce and Industry
Tel./fax: +7 (095) 132-7429
E-mail: extrade@mtpp.org

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ECOS, PJSC; EXPOECOS, Ltd
Tel.: +7 (095) 331-0501
331-1333
Fax: +7 (095) 331-0511
331-0900
E-mail: expoecos@nii-ecos.ru
www.nii-ecos.ru/expoecos

Military aviation

RUSSIAN AIR FORCE DRAWS 2002 RESULTS

Colonel General Vladimir Mikhailov, Russia's Air Force and Air Defence Commander, held a regular briefing on 15 January 2003, titled "Russian Air Force: 2002 results, status, and development prospects".

According to Gen. Mikhailov, front-line aviation of the Air Force held over 50 tactical flight training exercises last year; exercises in more than 50% of air regiments included training missile launches against air targets. Bomber and ground attack regiments held over 300 combat training exercises, and long-range aviation successfully launched ten airborne cruise missiles in 2002.

As contrasted to 2001, last year's annual flying time in the Air Force grew by 68% and averaged over 25h in fighter aviation, around 30h in ground attack aviation, over 20h in bomber aviation, around 25h in long-range aviation, and over 50h in military transport aviation.

Gen. Mikhailov stated that 2002 airspace combat duty along Russia's state border was associated with high tension. In the course of last year, the Air Force registered 45 cases of airspace regulations transgression and around ten airspace violation incidents involving airships.

Air Force and Air Defence duty units detected and tracked over 200,000 air targets, more than 100,000 of them of foreign affiliation, including over 1,000 combat aircraft and 300 reconnaissance aircraft. The red alert status was imposed on air crews around 600 times in 2002, on air defence missile units around 200 times, and on radio technical troops units 2,500 times; Air Force duty crews performed around ten airspace violation emergency sorties.

Gen. Mikhailov takes modernisation of the Air Force's fleet to be one of the priority development tasks in 2003. He believes that if the Air Force upgrades aircraft being in its inventory, as well as upgrades and sells off-budget aircraft left after the merger the Air Force and air defence troops it can then easily revive its mainstay fleet. Gen. Mikhailov reported that front-line aviation is expected to take around 20 upgraded 4+ generation aircraft in 2003.

RUSAF'S SU-27 MODERNISATION UNDERWAY

The first Su-27SM fighter upgraded for the Russian Air Force completed its first flight from the airfield of Komsomolsk-on-Amur Aircraft Production Association (KnAAPO) on 27 December 2002. The fighter was flown by Sukhoi test pilot Evgeny Frolov.

Under the programme to upgrade the Russian Air Force's fleet, KnAAPO is defined as the prime contractor for modernising service Su-27 fighters to the 4+ generation level. Su-27 single-seaters will be retrofitted to the level of exported Su-30MK twin-seat multirole fighters, but the resultant Su-27SM modification will have even greater capabilities than the Su-30MK for example. The upgraded fighter will get a cockpit indication system based on three LCDs, and will be capable of launching RVV-AE air-to-air missiles against two targets at once.

The first fighter under the upgrade programme was taken from an Air Force unit. In early 2003 it will be combat-tested at the RusAF State Flight Research Centre in Akhtubinsk and then returned to its assigned regiment. This year KnAAPO will upgrade five more Russian Air Force Su-27s.

AIR FORCE GETS ARMY AVIATION

On 1 January 2003 Army Aviation of Russia's Land Forces came under the command of the Russian Air Force. The Air Force assumed control of over 80 army aviation units, including over 20 helicopter regiments, one-based aviation institute, the Torzhok-based Army Aviation Combat Training and Aircrew Conversion Centre, one helicopter storage depot, and over 2,000 aircraft. Said Colonel General Nikolai Kormiltsev, Commander of the Russian Land Forces, "Helicopter regiments and combat support units formerly subordinate to the Army Aviation Command simply cannot operate efficiently without the Air Force. It is the Air Force that provides airfield maintenance, supplies spares, and enforces airspace control. Therefore, I supported the General Staff's idea of moving army aviation under command of the Air Force." The Defence Ministry is looking into the possibility of attaching aviation units of all service arms to the Air Force.

RUSAF TURNS TO KYRGYSIA

In late November 2002 the Russian Air Force commenced the forming of a composite air unit at the Kant airfield located 20km away from Bishkek, the capital city of Kyrgyzstan. The unit will comprise five Su-27 interceptors, five Su-25 ground attack aircraft, two An-26 military transports, five L-39 trainers, two Mi-8 helicopters, and two Il-76MD heavy transports. The air base will be manned by around 700 military and civilian personnel. The creation of the base follows a decision by member nations in the Collective Security Treaty (CST) signed by Armenia, Belarus, Kazakstan, Kyrgyzstan, Russia, and Tajikistan. Russian military aircraft will be the backbone of the CST member nations' joint rapid deployment forces in Central Asia.

SU-27KUB PROSPECTS

The first twin-seat carrier-borne Su-27KUB combat trainer demonstrator, under testing since 1999, is currently being upgraded to get the Sokol (Falcon) phased array radar developed by Phazotron-NIIR Corporation. The demonstrator will also be fitted with augmented thrust engines built by MMPP Salut Moscow Machine-building Production Plant. These modernisation measures will enhance the aircraft's performance.

Komsomolsk-on-Amur Aircraft Production Association (KnAAPO) is preparing to launch Su-27KUB production. A batch of these fighters might be built for the 279th Separate Carrier-borne Fighter Regiment based on the Admiral Kuznetsov aircraft carrier of the Northern Fleet; other production possibilities include deliveries to coast-based naval aviation units, in which Su-27KUBs might simultaneously replace several aged aircraft types like Su-24M ground-attack aircraft and Tu-22M3 missile-carrying bombers.

TODAY'S LONG-RANGE AVIATION FLEET TO REMAIN EFFICIENT TILL 2015

According to Major General Igor Khvorov, Commander of the 37th (Strategic) Air Army of the Supreme Command, Tupolev Tu-160, Tu-95MS, Tu-22M3 missile-carrying bombers and Ilyushin Il-78 tanker aircraft now in service with the Russian Air Force's long-range aviation will remain efficient till 2015, when the Future Long-range Aircraft (PAK DA) enters the inventory. The PAK DA concept is now being developed.

"We have worked out our requirements for the PAK DA. We then convened together with representatives of aircraft manufacturers. Each company offered a project. Having summed up our ideas and capabilities of manufacturers, we submitted the results to a research institute for assessment of the programme's production technology and cost. In the near future we will be provided with all the necessary data to be able to choose the contractor. And there's quite a choice," said Gen. Khvorov.

Meanwhile, the short-term focus is on modernisation of Tu-160, Tu-95MS and Tu-22M3 aircraft. Says Gen. Khvorov, "We are making new sighting/navigation systems and changing avionics, which allows for employment of new types of missiles and bombs. For instance, the Tu-160 hasn't been suited for bombing missions before. Now it is. We will 'teach' it how to do it, and then we'll have some practice in 2003." According to Khvorov, conventional precision guided weapons made long-range aviation "a non-nuclear deterrence" force.

Modernisation activities will be combined with the planned overhaul of aircraft, usually performed once every 8-10 years of operation. Tu-160s and Tu-22M3s will be upgraded by the producer, the Kazan Aircraft Production Association, while Tu-95MS aircraft will be modernised by either the Samara-based aircraft plant or the Taganrog-based TAVIA aircraft plant. The latter will also upgrade the Russian Navy's Tu-142M long-range ASW aircraft.

SUPER FLANKERS FOR RUSSIAN KNIGHTS

Pilots of the Russian Knights display team attached to No 237 Aircraft Demonstration Centre named after Air Force Marshal Ivan Kozhedub have started retraining to fly a new aircraft type, the single-seat Su-35 multirole fighter. By the summer of 2003 the team is expected to have mastered formation flights and aerobatic manoeuvres within a five-ship Su-35 group. Three Su-35s will be delivered from the Russian Air Force State Flight Research Centre, which took them from Komsomolsk-on-Amur Aircraft Production Association (KnAAPO) in 1996. Two more machines will be taken from Sukhoi Design Bureau. The Russian Knights' current four-ship Su-27 group comprises Igor Tkachenko (group commander), Dmitry Khachkovsky, Igor Shpak, Oleg Ryapolov, and Eduard Zhukovets (solo pilot). New pilots training to perform with the team in future seasons. Adoption of Su-35s, which differ from Su-27s in much greater manoeuvrability and carry in-flight refuelling system, will add to the beauty of the team's displays and enable the Russian Knights to perform long-range non-stop flights to air shows all over the world.

Industry

PAK FA DEVELOPMENT

According to Mikhail Pogosyan, Director General of the Sukhoi Design Bureau, the conceptual design of a fifth-generation fighter will be ready in 2003, and will be submitted for consideration in 2004. Mr Pogosyan said that Sukhoi is currently identifying contractors to develop onboard equipment for the future fighter. "We already know what major contractors to cooperate with. The engine will be developed by NPO Saturn Scientific Production Association, our long-standing partner. Other systems will also be developed by many of our traditional partners," Mr. Pogosyan said.

IAIA GOT A NEW NAME

At a 19 December 2002 extraordinary meeting, shareholders of the Irkutsk Aviation Industrial Association (IAIA) approved change of the company's name to Joint Stock Company Scientific Production Corporation «Irkut». Irkut's President Aleksei Fedorov said the move was caused by the fact that the corporation was joined by a number of scientific, design and production enterprises, such as the Russian Avionics Design Bureau, Beriev company, etc. Moreover, Irkut is considering purchase of a stock in a plant situated in European Russia and majoring in production of civil aircraft.

SU-25SM TESTS

The upgraded Sukhoi Su-25SM attack aircraft prototype, designed to serve as the blueprint for upgrading the Russian Air Force's in-service Su-25s, completed a 41-flight development testing programme in December 2002 and was submitted for official tests. Vladimir Babak, the Su-25 chief designer, says the official testing programme will take around one year to complete and will include hundreds of flight tests on several prototypes. A second Su-25SM will enter the programme in early 2003. Overall, four Su-25s will be upgraded this year by the Kubinka-based 121st aircraft repair facility, including one Su-25UB combat trainer. The latter will be ready in the third quarter of 2003 and will enter flight tests under the designation Su-25UBM.

FOUR YAK-130s TO BE PRODUCED IN 2003

In November 2002 Colonel General Vladimir Mikhailov, Russian Air Force Commander, visited the Nizhny Novgorod-based Sokol Aircraft Plant, which has launched production of prospective Yak-130 combat trainers. This year the enterprise will build four such jets for ground and flight tests. The first Sokol-built Yak-130 may be presented at the International Air Show in Le Bourget in June 2003.

Flight testing of the first Yak-130 prototype is scheduled to begin in the summer of 2003 (the Yak-130D trainer, which has been tested ever since 1996, is a technology demonstrator). Sokol will build the fourth Yak-130 by the year-end; the aircraft will enter flight testing in early 2004. In the course of 2004 the Yak-130 may be officially tested to establish its suitability for adoption by the Russian Air Force.

The Air Force believes it necessary to speed up production of the initial Yak-130 batch. Says Yak-130 chief designer Konstantin Popovich, "We are planning to start production of the first ten Yak-130s already in 2005, not in 2008 as was previously planned." This amendment of the initial production plan is explained by the Air Force's great demand for the new combat trainer. Gen. Mikhailov says that after the Air Force has taken the initial batch of Yak-130s the Sokol Aircraft Plant will be contracted for mass production of these aircraft.

Experts estimate the Russian Air Force's demand for the Yak-130 combat trainer as not fewer than 200 aircraft, with the global market capacity for the Yak-130 possibly reaching 800-1,400 aircraft.

NEW SUKHOI'S TRAINER

The Sukhoi Design Bureau in late 2002 completed preparation of technical documentation for its new twin-seat Su-49 basic and advanced trainer. In October 2001 Sukhoi won the Russian Defence Ministry's tender to develop a piston-engined trainer. Su-49 production will be launched at the Novosibirsk Aircraft Production Association. The Russian Air Force might order 300 such aircraft, 1,000 more might be purchased for domestic flying clubs.

AN-38-200 COMPLETED TESTS

November 2002 saw the completion of certification tests of the multipurpose An-38-200 short-haul passenger/cargo aircraft powered by two TVD-20 turboprop engines. The aircraft completed its first flight on 11 December 2001. Most of certification tests were held in the Novosibirsk Region; six test flights were held in Ukraine in the summer of 2002, and magnetic consistency tests were held near Feodosia. He aircraft's anti-icing system was tested in the Omsk Region. The Novosibirsk Aircraft Production Association is ready to launch production of the new aircraft. A TVD-20-powered An-38-200 will sell for $3.5 million, or 45-50% cheaper than the price of a production An-38-100 powered by US-made engines.

ONE MORE TU-214 BUILT FOR RUSSIA

On 15 November 2002, Kazan Aircraft Production Association (KAPO) rolled out Tu-214 No 64505. Following a series of ground tests, on 17 December 2002 captain Aleksei Ryabov, copilot Nikolai Kapelkin, navigator Georgy Tsykun, engineer Igor Arapov, and leading engineer Valishev performed a 2h30min maiden flight from the KAPO airfield.

The Tu-214 had completed seven flights by 13 January 2003. Later this month it will be delivered to State Transport Company Rossia.

KAPO is readying two more Tu-214s, No 64506 and 64507, for the same operator. Rossia took its first Tu-214 (No 64504) in the autumn of 2002.

TUPOLEV'S PROSPECTIVE TRANSPORT

On 24 December 2002 Tupolev Design Bureau organised a round-table dedicated to the company's prospective transport aircraft project. Tupolev specialists reported the progress with the Tu-204-330 programme: the prospective airplane shed its former Tu-330 designation in 2002 to highlight the design continuity from production aircraft of the Tu-204/214 family.

The only current restraint on the Tu-204-330 programme is lack of finance. Project Chief Designer Valentin Bliznyuk noted that building four aircraft (two ground test demonstrators and two flyable machines) and getting the airplane certificated requires around $100 million in investments. Said Mr. Bliznyuk, "Kazan Aircraft Production Association (KAPO) is ready to launch Tu-300 production; the production programme is based on proven – and certified – design solutions and is, therefore, risk-free."

KAPO is ready to launch Tu-204-330 production four years after the financing begins. The aircraft may cost $25-27 million apiece.

The Tu-204-330 inherits the Tu-204/214 family's proven aerodynamics, certified cockpit and avionics, reliable flight control system, and a power plant of two PS-90A turbofan engines. The aircraft's performance may be further improved as soon as the NK-93 engine gets available.

Mr. Bliznyuk says KAPO has already built a preliminary batch of ten NK-93s. The engine may get certified already this year, after flight tests on an Il-76LL flying testbed. "An NK-93-powered Tu-204-330 would fully comply with ICAO noise and emission standards," Mr. Bliznyuk adds.

TACTICAL MILITARY TRANSPORT TENDER

The Russian Air Force is completing a tender for creation of a lightweight tactical military transport aircraft (TVTS programme). The tender was initially planned for completion in late 2002 – early 2003. The contestants are the Tupolev Design Bureau, the Myasishchev Experimental Machine-building Plant, the Sukhoi Design Bureau, Russian Aircraft Corporation MiG, and the Ilyushin Design Bureau. The MiG-110 and Il-112V projects are believed to be the primary rivals in the tender. The programme to create a dual purpose transport aircraft with a carrying capacity of six tonnes is also part of the federal programme to develop civil aviation in 2002 through 2010 and through to 2015. Under the programme, the future aircraft is to be certified in 2008, while its development is to be accomplished by 2010.

CONTESTS FOR FUTURE AIRLINERS

The Russian contests for a future short- and medium-haul aircraft (BSMS programme) and for a new regional aircraft entered the final stage in December 2002. The former contest had only two nominees running, the Yak-242 by the Yakovlev Design Bureau and the Il-214 by the Ilyushin Design Bureau. The Tupolev Design Bureau, although not running in the contest, claims the Tu-204-300, a shortened version of its Tu-204-100 passenger aircraft seating up to 160 passengers and having a range of 2,650km to 9,250km, would be an optimal option. The panel of the regional aircraft contest will consider the Tu-414 by the Tupolev Design Bureau, the M-60-70 by the Myasishchev Experimental Machine-building Plant, and the Russian Regional Jet (RRJ) developed jointly by the Sukhoi and Ilyushin Design Bureaux.

M-101T GZHEL GETS CERTIFIED

On 14 January 2003 Anatoly Kruglov, chair of the Interstate Aviation Committee's Aviaregistr certification body, awarded Myasishchev Experimental Machine-Building Plant (EMZ) a type certificate for the M-101T Gzhel aircraft.

Held in the town of Zhukovsky, the Moscow Region, the ceremony was attended by Myasishchev Designer General Valery Novikov, Kaskol Group president Sergei Nedoroslev, Mikhail Shibayev, acting Director General of Sokol Aircraft Plant, and representatives of the Russian Aerospace Agency, state civil aviation authority, Central Aerohydrodynamic Institute TsAGI, Gromov Flight Research Institute, the State Scientific Research Institute of Civil Aviation, and Russian carriers.

The certificate was issued on 30 December 2002. It certifies the M-101T standard construction as corresponding to the "basic M-101T certification requirements" and compliant with airworthiness requirements under AP-23 standards for lightweight standard category civil aircraft.

On 3 December 2002 the Gzhel was awarded a "lateral noise certificate" establishing that the aircraft "fitted with the M601F-22 engine and V-510 propeller complies with Chapter 10 of ICAO Annex 16 and with AP-36 Annex G".

Certification of Russia's first business turboprop gives a go-ahead to Gzhel marketing and authorises registration and addition to the "Register of Russia's civil aircraft", thus enabling unrestricted commercial operation of this aircraft. This will allow the manufacturer to finalise existing Gzhel sales contracts with several Russian and foreign carriers.

The Gzhel demonstrator completed its first flight on 31 March 1995. Two flying demonstrators, two ground test demonstrators, and six pre-production aircraft have by now been manufactured by now. Sokol Aircraft Plant has launched production of the first 15-strong Gzhel batch.

Contracts

SUKHOI'S EXPORT RESULTS

AVPK Sukhoi company had fulfilled its obligations under 2002 export contracts, said the company's Director General Mikhail Pogosyan, adding that in 2002 Sukhoi exported over 60 aircraft. The number includes both newly built Su-27/Su-30 family fighters and repaired and upgraded aircraft from the Russian Defence Ministry's reserve (most likely Su-24MK frontline bombers). On the 2002 list of major deliveries are 10 Su-30MKIs for the Indian Air Force (supplied in June-August), and 19 Su-30MKK fighters for the Chinese Air Force (10 supplied in August and nine in December). Mr. Pogosyan stressed that Sukhoi's overall volume of export accounted for 40% of the international frontline aircraft sales level. According to Pogosyan, currently Sukhoi ranks second in the world where the volume of frontline fighters production is concerned, US Boeing ranking topmost.

AEROFLOT GETS NEW AIRBUSES

On 18 November 2002 in Toulouse, Aeroflot Director General Valery Okulov and Airbus Industrie President Noel Forgeard signed a contract on purchase of a large batch of A319/A320 aircraft by Aeroflot. The signing ceremony was attended by Russian Prime Minister Mikhail Kasyanov and his French counterpart Jean-Pierre Raffarin. Under the contract, Russia's flag carrier will lease 18 Airbus airliners with the right to buy them out. The $600 million deal will be implemented in three stages. In the first stage, in the mid-2003, Aeroflot will lease from Airbus six A319s and two A320 for a period of 12 years. US leasing company General Electric Capital Aviation Services (GECAS) will deliver another ten aircraft (four A319s and six A320s) to Aeroflot in two takes: four in early 2004 and six in late 2004. GECAS will also lease to Aeroflot three Boeing 767-300ERs for up to six years.

TU-204 FOR CHINA ET AL

On 13 November 2002 in Moscow, V/O Aviaexport PLC, Tupolev Design Bureau, and Aviastar-SP JSC signed a contract to deliver 25 Rolls-Royce-powered Tu-204-120 aircraft to Sirocco Aerospace.

Sirocco will earmark 15 airplanes for deliveries to China under a firm order for five cargo Tu-204-120Cs and an option for ten more. V/O Aviaexport Director General Felix Myasnikov said no purchasers have yet been identified for the remaining ten aircraft. "We are negotiating with several potential customers. Egypt is interested in a deal, as are a number of Middle Eastern, African, and Asian countries," Mr. Myasnikov added. Courier company TNT might purchase the batch of Tu-204-120s under its fleet renewal programme.

According to Mr. Myasnikov, Russia's share in the entire contract would be in the region of $350 to 355 million. Sirocco Aerospace will fit the aircraft with engines, auxiliary power units, avionics, and certain onboard equipment. The Egyptian partner will also cover all expenses on certification under Chinese regulations and according to the JAR standards.

Says Mr. Myasnikov, "The first airplane will be ready by year-end; we expect to hand it over to a Chinese customer in the first quarter of 2004. If the current contract terms are not revised, the last of the 25 aircraft will be delivered in 2006."

Tupolev Designer General Igor Shevchuk puts the company's entire order portfolio for the Tu-204 family at around 100 aircraft.

NEW ANTONOVS FOR AEROFLOT

Russian leasing company Ilyushin Finance Co. in 2003 will begin purchases of 25 Antonov An-74TK-300 aircraft from the Kharkov State Aircraft Manufacturing Company (KSAMC). The aircraft will be leased to Russia's flag carrier Aeroflot to replace its ageing fleet of Tu-134 passenger jets. Further down the road Aeroflot is planning to replace leased An-74TK-300s with new An-148 short-haul 72-seaters, to be produced by KSAMC starting in 2005. If the An-148 production programme gets expedited, Aeroflot may curtail the number of An-74TK-300 to be leased and return them to Ilyushin Finance Co. as soon as the An-148 is available. The An-74TK-300's initial price is $12-14 million, whereas the An-148 is expected to sell for $14-16 million apiece. Aeroflot is forced to purchase new short-haul passenger aircraft from Ukraine because similar Russian-made airplanes will hit the stores only in 2010, whereas the carrier's fleet of Tu-134s must be replaced as soon as possible.

VYBORG WILL RECEIVE THE THIRD IL-114

In January 2003 the Vyborg air carrier is to get from the Tashkent Aircraft Production Corporation (TAPC) the third Il-114 regional airliner. The carrier plans to operate a total of five Il-114s fitted with Russian-made engines and avionics. Vyborg is the first Russian carrier operating such airplanes. The first Il-114-100 powered by Canadian-produced engines and foreign-made avionics was obtained by the Uzbek national carrier, which is to get three more liners of the type.

Flight safety

THE FAMOUS 711 LOST

On 19 December 2002, a supermanoeuvrable Su-35 single-seat fighter demonstrator, the legendary aircraft No 711, owned by the Sukhoi Design Bureau crashed during a test flight from the Gromov LII Flight Research Institute airfield. Yury Vashchuk, a test pilot with Sukhoi Design Bureau, safely ejected and was found by a rescue party a hour and a half after the crash. Mr. Vashchuk, 1st Category Test Pilot and a world-class aerobatics pro, was hospitalised with minor injuries.

The aircraft crashed 79km to the east of the LII airfield after the pilot ventured a flight task to determine stability and controllability parameters of the aircraft with modified fly-by-wire system in testing flying area. According to unofficial sources, at around 15:15 Moscow time a high-g manoeuvre destroyed an attachment point of a stabiliser console, separating the latter from the airframe. Consequent destruction of hydraulics piping resulted in massive hydraulic fluid losses and lead to complete failure of the flight control system. The pilot bailed out at less than 1,000m and was later found suspended from a tree, his parachute having got caught in the treetop. The aircraft crashed in swampland 5km to the south west of the town of Shatura.

The Su-35 No 711 (factory-designated T10M-11), was built in 1994; in 1996 it was fitted with experimental thrust vector control engines. Test pilot Yevgeny Frolov used the aircraft to practice, and repeatedly demonstrate at international air shows, manoeuvres previously inaccessible to jet fighters. Under the designation Su-37 this aircraft starred at Farnborough 1996 and Le Bourget 1997, and then at a number of other European, Latin American, and South-East Asian aerospace exhibitions.

After the experimental AL-31F thrust vectoring engines exhausted their service life in 2000, the Su-35 No 711 was fitted with standard production engines. In spite of that the modified fly-by-wire system enabled the fighter to retain its supermanoeuvrability. Test pilot Yury Vashchuk, who was assigned to the upgraded fighter in 2000, demonstrated its unique flight capabilities during the MAKS 2001 air show, and then at the Seoul exhibition, where the aircraft was used as the Su-35 fighter demonstrator running in South Korea's tender.

In-flight destruction of production structural elements of the demonstrator's empennage apparently resulted from repeated exposure to off-design loads during the 6-year T10M-11 operation beyond performance restrictions. Specialists take aircraft of the Su-27 family, under which category the Su-35 is subsumed, to be highly reliable provided that the imposed operation instructions and restrictions are observed. In particular, the aircraft's fly-by-wire system has quadruple redundancy and might have supported a safe return to base but for the disastrous concatenation of circumstances (history knows happy examples like the 1983 incident, when test pilot Nikolay Sadovnikov managed to land a Su-27 with severely damaged wing and empennage). Flight tests and flight operation of Su-35 (Su-27M) fighters started in 1988 saw not a single aircraft of this type had been lost to an accident or crash ever since.

Representatives of Sukhoi Design Bureau express hope that the Su-35 No 711 crash won't affect the fighter's chances in a number of international tenders. The Su-35 is currently running in a Brazilian tender, and several years later it is to become Sukhoi's major exportable.

TRAGEDY IN IRAN'S SKY

At 19:29 local time on 23 December 2002, the An-140 UR-14003 of Ukrainian carrier Aeromist-Kharkov crashed during landing approach near Isfahan Airport (Iran), killing all 44 aboard. The crash claimed the lives of three crewmembers, three engineering service specialists, and 38 passengers.

Special flight AHW 2137 was enroute from Kharkov to Isfahan via Trabzon (Turkey) to deliver a delegation to the roll-out ceremony of a second Iranian-built IrAn-140 aircraft. The passengers were representatives of Ukrainian and Russian aircraft enterprises cooperating in the Ukraino-Russo-Iranian An-140 programme. The crew performed the VOR/DME-aided landing approach after sunset. Due to a considerable deviation from the prescribed approach route, 33km off the airport's VOR beacon the aircraft collided with a 2,400m-high mountain at some 2,380m above ground and completely disintegrated.

The An-140 (s/n 0204) was rolled out at Kharkov State Aircraft Manufacturing Company (KSAMC) on 30 November 2002 (less than one month before the crash); by the time of the crash it had flown 71h28min and performed 27 landings. The An-140 was delivered to Ukrainian carrier Aeromist-Kharkov under the latter's leasing agreement with Ukrtransleasing, the owner of the aircraft.

Under an agreement between Aeromist-Kharkov and KSAMC, the aircraft was operated by KSAMC test pilots Gennady Antsibor (captain) and Sergei Chaichenko (inspector, co-pilot). Either pilot was highly qualified and had an extensive An-140 experience. Either had a record of An-140 landings at Isfahan airport. 2nd Category Test Pilot Gennady Antsibor had a total flight experience of 2,000h, including 160h on An-140, and had previously performed seven successful landings at Isfahan. 1st Category Test Pilot Sergei Chaichenko had a total flight experience of 6,600h (including 5,500h as captain), of this amount 651h on An-140, and had previously performed 16 successful landings at Isfahan.

By 20 January 2003 the investigation commission had not yet revealed its conclusions as to why the aircraft had deviated from its course, but our sources reported that interpretation of data on the crashed An-140's flight recorders had confirmed proper functioning of all onboard systems immediately prior to the collision.

The Iran tragedy claimed the lives of excellent pilots, engineers, designers, and other aviation specialists. As the fate willed, the An-140 was carrying our friends and colleagues who had repeatedly submitted articles for our magazine: Vladimir Kolesnikov, Chief Designer and first deputy Head of the Ivchenko-Progress Design Bureau, Mikhail Ternov, chief of the KSAMC marketing service, Sergei Skrynnikov, an unsurpassed master of aviation photography and essentially the pioneer of contemporary Russian aviation journalism... Their memory is embalmed in our hearts. Air Fleet commiserates with the families of the deceased.

The 23 December 2002 air crash in Iran killed Sergei Skrynnikov, Editor-in-Chief of Aerospace Herald. He was a wonderful journalist, master of aviation photography, man of exceptional generosity...

Sergei Skrynnikov was born on 3 May 1959 in Makeyevka, Donetsk Region. After school he went to army, then studied journalism at Moscow State University. When in his third year, he was sent to Aviation and Cosmonautics magazine for probation. That first tour of aerodromes changed his life once and for all – he fell in love with aviation, and never imagined his life without meeting pilots, without living in the magnificent world of aviation, the world that never failed to spark new ideas. When a competition was announced to select a journalist to go to the Mir space station, Sergei managed to get on the list of candidates and passed through the necessary tests and special training.

For Skrynnikov it was a time of new impressions, which he skilfully embodied in exquisite photos. Having been allowed a place in the second cockpit of combat aircraft, he availed of the opportunity to make a great many priceless, both historically and artistically, pictures that may be justly considered national endow of photo documentation.

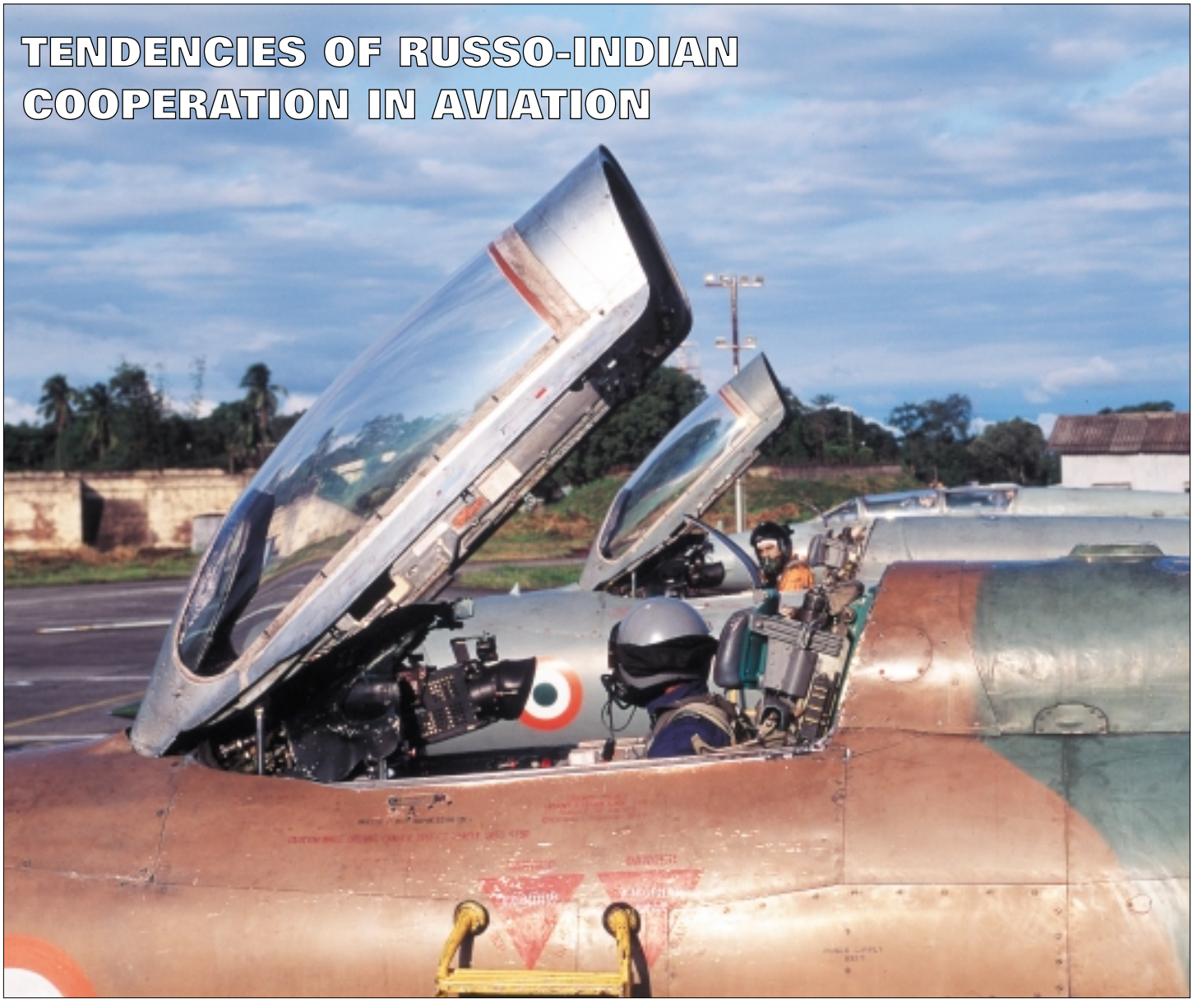
In 1995 Sergei Skrynnikov embarked on a new undertaking – he headed the editorial staff of revived Air Fleet Herald magazine. Energetic and enthusiastic, he helped the magazine win back its faithful audience.

His talent, recognised all over the world, would always win him a place in the aviation photographers' top ten. The chronicle of Russian aviation, portrayed in his pictures, is the best monument to our friend and colleague, whose heart, full of creative ideas, suddenly stopped beating. Many will miss his smile, his friendly support, his companionship. But what will remain is remembrance of joint work, meetings, journeys...

Air Fleet

FROM AIRCRAFT SALES TO JOINT PROGRAMMES

TENDENCIES OF RUSSO-INDIAN COOPERATION IN AVIATION



India appears to be a next-to-ideal partner in military technology cooperation with Russia; there are virtually no politico-military risks for Moscow in relations with New Delhi. Russia has a fair-sized record of successful joint programmes with India: for 40 years now, Russia has been exporting advanced warplanes to that country. Ever since the second half of the 1960s, MiG and Sukhoi aircraft have constituted the backbone of the Indian Air Force (IAF) fighter and fighter-bomber aviation, with a lion's share of the IAF MiGs produced in India under Soviet license. The IAF and the Indian Navy operate a large number of Russian-made Mil and Kamov helicopters of various types and modifications, and the Indian Navy's long-range ASW aviation flies Russian-built Il-38s and Tu-142s. The IAF military transport aviation has in its inventory Il-76 jets and An-32 turboprops imported from the former USSR.

And yet the relations between Moscow and New Delhi are not devoid of certain hardships, such as India's lack of financial resources and extensive lobbying of the country's market by Israeli, French, and – of late – US companies. While importing Soviet – and later Russian – aircraft, India has always strived to avoid dependence on a single supplier country. This is why, along with MiGs, Indian military aviation operates French Mirages, British Harriers and Jaguars, and other types of foreign warplanes. Other examples of this no-single-sources policy are the internationalisation of the IAF's Su-30MKI programme and attempts to interest Israeli and French businesses in upgrading the IAF's Soviet-built aircraft. For positive dynamics to remain, Russo-Indian relations must be given a new powerful stimulus such as, for example, penetration of Indian capital into the Russian defence industry, and vice versa.

40 years with MiGs

MiG-21FL became the first fighter of Russian design in the IAF

Until the early 1960s, the major part of the IAF's warplane fleet was of British origin. This can be explained by historical relations between the two countries: India had long been part of the British Empire. France and the US also used to export aircraft to New Delhi. The IAF pinned some hope on domestic manufacturers who had, by the mid-1950s, gained certain experience in licensed assembly of British De Havilland Vampire and Folland Gnat jet fighters. The IAF was eager to renovate its inventory in the face of a tense situation on the border with Pakistan, which had just received advanced F-86 and F-104 fighters from the US.

The defence cooperation between India and the USSR started in the early 1960s when New Delhi, in its searches for a new fighter type, preferred the MiG-21 to the French Mirage III. An intergovernmental agreement signed in August 1962 provided for MiG-21 deliveries and organisation of licensed MiG-21 production in India.

The first MiG-21F-13s reached India in April 1963; two years later these fighters were supplemented by modernised all-weather MiG-21FL interceptors (the export variant of the Soviet MiG-21PF) with onboard radar. Simultaneously, the USSR started deliveries of MiG-21U twin-seat trainers.

In 1964, enterprises of Hindustan Aeronautics Limited (HAL) began preparations for assembly of MiG-21FLs from Soviet kits. HAL established a so-called MiG Complex that comprised several enterprises: the Nasik division was charged with airframe manufacture and final assembly of MiG-21FLs; the Koraput division was to launch production of R11F2S-300 engines; and the Hyderabad division was entrusted with production of avionics and air-to-air missiles.

The Nasik division launched licensed production of MiG-21FL (Type 77) in November 1966. The first Indian-assembled fighter was handed over to the IAF in 1967, and the first indigenously built MiG-21FL was added to the IAF inventory on 19 October 1970. The Indian national aircraft industry manufactured 197 such fighters by 1974, when a more advanced version, the MiG-21M (Type 96), was phased in. The new fighter was basically the export variant of the Soviet MiG-21SM and differed from the predecessor in advanced avionics and increased fuel load. All in all, together with aircraft imported from the Soviet Union, the IAF got around 300 MiG-21FLs (Type 77) and twin-seat MiG-21U/US trainers (Type 66). Despite their age, many of these machines are still in service with the IAF. The first 14 MiG-21F-13s imported from the Soviet Union were retired in 1968.

By the end of the 1960s imported and licensed-built MiG-21FLs had replaced British-made Vampires in four IAF squadrons. Indian-produced MiGs saw action during the Indo-Pakistani conflict in the early 1970s. On 12 December 1971 a MiG-21FL pilot with 47th Black Archers Sqn shot down a Pakistani F-104, opening the score that was brought up by many of his colleagues in years to follow.

In 1971 HAL's Nasik division launched licensed production of MiG-21M fighters powered by the R11F2S-300 engine; the IAF took the first Indian-assembled aircraft on 14 February 1973. HAL built a total of 200 such fighters; the last of them was handed over to the IAF on 12 November 1981. MiG-21Ms replaced British-made Hawker Hunters and Folland Gnats in five squadrons. The IAF perceived MiG-21Ms as fighter-bombers. In all, together with machines exported from the Soviet Union, the IAF got around 240 MiG-21M fighters and twin-seat MiG-21UM trainers (the IAF's overall total number of imported twin-seat MiG-21U, MiG-21US, and MiG-21UM trainers was brought up to 70 when India purchased another ten used aircraft from an East European country in 1994 and 1995).

IAF's MiG-21bis served in IAF's No 24 Sqn now equipped with Sikhoi Su-30Ks

India's licensed MiG-21 production programme didn't stop at that. Despite emergence of next generation fighters, the IAF expressed the desire in 1976 to take a new modification of the Soviet aircraft, the MiG-21Bis (the last Soviet production MiG-21 variant featuring upgraded equipment and the new R25-300 engine). The first of these fighters were delivered to India in 1977 to replace Folland Gnats in three IAF squadrons. Unlike the MiG-21M, the IAF saw the MiG-21Bis as a multirole fighter. In all, the Soviet Union sold India some 75 Mig-21Bis fighters; HAL's Nasik division enterprise launched indigenous MiG-21Bis (Type 75) production in 1983 and terminated the programme in 1987, having built 220 fighters.

Of the nearly 580 Indian-built and some 250 imported MiG-21s, about a third continue service with Indian aviation, accounting for the largest portion of the IAF's fleet of fighters. Three hundred MiG-21s are still operated by the IAF; 200 of them are MiG-21bis aircraft, in service with ten fighter squadrons (3rd, 4th, 15th, 21st, 23rd, 26th, 32nd, 36th, 37th, and 45th Sqns). The IAF uses earlier MiG-21 modifications as trainers: 40 MiG-21FLs and 38 twin-seat MiG-21U/US/UM aircraft are kept for pilot training at MiG Operational Flying Training Unit (MOFTU; for more details see the corresponding article in this issue), and 12 MiG-21Ms are used for basic fighter pilot training at the IAF's Tactical & Air Combat Development Establishment. Around five dozen MiG-21FLs and the same number of MiG-21Ms, which until recently had constituted the mainstay of three fighter and three strike squadrons (Nos. 8, 30, 52 and 17, 101, 108, respectively), are now retired and transferred to reserve. Twelve MiG-21R reconnaissance aircraft and ten MiG-21Ms retrofitted for ECM operations continue service with 35th Sqn.

On 1 March 1996, India signed a contract with Russian Aircraft Corporation MiG and the Nizhny Novgorod-based Sokol Plant on upgrading the IAF's

Three vividly coloured MiG-21Ms from the IAF's No 101 Sqn in formation

The following sources were used in writing the article: Directory: World Air Forces (Flight International, 27 November – 3 December 2001); World Air Forces Directory 2002/2003 (edited by I.Caroll, Mach III Plus, UK, 2002); Aerospace Encyclopedia of World Air Forces (edited by D.Willis, Aerospace Publishing/AIRtime Publishing, UK/USA, 1999); IAlka Sen. Glimpses into Indian Aviation History. 1910-1997 (Bombay/London, 1998); Russia in the World Arms Market. Analysis and Prospects (by B.Kuzyk, N.Novichkov, V.Shvarev, etc. Military Parade, Moscow, 2001), as well as news bulletins: Military Technology Cooperation (Ed. N.Novichkov), Russia in the Arms Market (2001-2002) and Interfax-AVN on-line news.

The first Indian MiG-21bis fighter upgraded by Sokol plant in Russia

125-strong fleet of MiG-21bis fighters; under the contract, the aircraft will get the advanced Russian-made Kopyo (Spear) radar, new Russian-built guided weaponry (including RW-AE and R-73E air-to-air missiles, KAB-500Kr TV-guided bombs, etc.), a French navigation system, an Israeli ECM system, and a variety of Indian-made systems. The upgrade measures are expected to preserve the MiGs' combat potential and enable them to efficiently counteract later-generation warplanes for at least ten more years.

On 3 October 1998, the first IAF MiG-21bis upgraded by the Sokol Plant completed its first flight in Nizhny Novgorod. The trial programme run in Russia on two Russian prototypes and two IAF fighters had been generally completed by the end of 2000; the first two upgraded MiG-21bis UPG fighters returned to India on 14 December 2002. HAL's Nasik division in 2001 launched a programme to upgrade the remaining 123 IAF MiG-21bis fighters; the Sokol Plant and other Russian subcontractors delivered the necessary upgrading equipment kits to India. The first Indian-upgraded fighter, dubbed MiG-21 Bison, took off for its first flight on 31 August 2001. According to our sources, several dozens of MiG-21bis aircraft had been under modernisation by the end of 2002 (or have already been modernised by now). The programme is scheduled for accomplishment by 2005.

MiG-21s will remain in service with the IAF until the early 2010s. According to the IAF Command's plans, these aircraft will be replaced by future home-made lightweight fighters currently being developed under the LCA (Light Combat Aircraft) programme. Following a series of delays, the TD-2 (second Technology Demonstrator) LCA finally made its first flight in August 2002. The demonstrator was built in August 1998. The LCA programme, which was launched back in 1983, generally seems to be progressing at a much slower pace than was initially planned. A full-scale mock-up was not built until 1993, and the first technology demonstrator, the TD-1, was only rolled out in late 1995. The TD-1 made its first flight on 4 January 2001. Flight tests of the third demonstrator, built in 1999, were scheduled for late 2002. This must become the first of six LCA prototypes to undergo the major part of tests. The plans for the LCA's service entry with the IAF are now under revision: the initial operational readiness of the first LCA-outfitted combat units is expected to be reached not earlier than 2012-2015. So it looks like upgraded MiG-21bis fighters will be around for some time ...

New MiGs for India

A Soviet-Indian intergovernmental agreement signed in the summer of 1966 envisioned export to India of the newest Soviet Sukhoi Su-7BMK supersonic fighter-bombers. New Delhi's decision to purchase these front-line strike aircraft was caused by hold-ups with India's indigenous HF-24 Marut programme. In 1968 and 1969, 152 Su-7BMK fighter-bombers and twin-seat Su-7UMK trainers were delivered to India. The first such aircraft arrived in March 1968, and by the beginning of the 1971 Indo-Pakistani conflict the IAF had already formed six Su-7BMK squadrons. These aircraft "made India's war" by massively taking out ground and air targets.

Time went on, and by the early 1980s war-weathered Su-7BMK fighter-bombers and indigenous Ajeet ground attack aircraft and Marut fighters had become obsolescent and required replacement. Under the Tactical Air Strike Aircraft (TASA) programme, the IAF chose as the replacement Soviet MiG-23BN fighter-bomber, locally dubbed Vijay (Victory). These aircraft entered service with four IAF squadrons. The IAF additionally ordered Franco-British SEPECAT Jaguar attack aircraft from the UK. The first MiGs arrived in 1980; Jaguar deliveries began a year later (subsequently, HAL launched licensed assembly of Jaguars). Along with 95 MiG-23BNs the Soviet Union sold India 15 twin-seat MiG-23UB trainers.

Apart from MiG-23BN purchases, in the early 1980s New Delhi inquired the Moscow about the possibility of launching licensed assembly of upgraded MiG fighter-bombers. The corresponding contract targeted the MiG-27ML, the export version of the Soviet MiG-27M, with efficiency and weaponry capabilities

The first MiG-21 Bison upgraded by HAL in India

Five MiG-27ML Bahadurs in formation

exceeding those of the MiG-23BN. HAL's Nasik division, assisted by the Irkutsk Aviation Industrial Association (IAIA), launched assembly and servicing of these fighter-bombers, which were locally dubbed Bahadur (Courageous). The Koraput division, assisted by the Ufa-based Engine Plant, began assembly of R29B-300 turbojet engines for these aircraft.

In 1982 IAF became the only operator of the MiG-25RB Mach 3 high-altitude reconnaissance planes in the region

The first Indian-assembled MiG-27ML, made with components shipped from Irkutsk, was tested on 11 January 1986; two years later, the first all-Indian Bahadur was built. The first MiG-27MLs were delivered to the IAF's 222nd Sqn – that was the last unit still operating Su-7BMKs, which were retired nationwide in 1986. With time, new aircraft were delivered to IAF squadrons formerly outfitted with Ajeets. The MiG-27ML production programme at HAL's Nasik division was closed down in March 1997, after 165 such aircraft had been built.

India also ordered from the Soviet Union specialised high-altitude, high-speed MiG-25RB aircraft for aerial reconnaissance on the Pakistani border outside the range of Pakistan's fighters and air defences. In September 1982, India took delivery of six single-seat MiG-25RBs and two MiG-25RU twin-seaters, becoming the only owner of this as yet unsurpassed aircraft in the region.

Alarmed by Pakistan's purchases in 1981 and 1982 of US-made F-16A fighters, the Indian government sought options for outfitting the IAF with warplanes capable of efficient counteraction to American second-generation aircraft. At that point, the only adequate Soviet warplane available was the MiG-23MF front-line fighter, whose design was close to that of the MiG-23BN, already in service with the IAF. India took delivery of 45 such fighters, dubbed Rakshak (Protector), in 1982 to form two IAF squadrons. MiG-23MFs became the first IAF fighters armed with medium-range air-to-air missiles and capable of beyond-visual-range (BVR) fight. Along with MiG-23MFs, Russia sold India several twin-seat MiG-23UM modified trainers.

MiG-23BN of the IAF's No 220 Sqn firing rockets

New Delhi realised that MiG-23MF purchases were just a palliative, and that only new-generation fighters might match F-16s in the air. So, in 1982, India also ordered around 50 fourth-generation Mirage 2000H/TH fighters from France. These Mirages entered service with two IAF squadrons in 1985 and 1986.

In the meantime, the Soviet Union had completed testing and started operation of its own fourth- generation fighter, the MiG-29. Indian pilots who had a chance to fly the MiG-29 in 1984 were much impressed with the aircraft's performance. Already the same year India ordered 48 MiG-29s. The first fighter was shipped in December 1986, following a course of relevant training for several groups of Indian pilots and maintenance specialists at Soviet training centres.

The official service entry of MiG-29s, locally dubbed Baaz (Falcon), took place at an air base near the Indian town of Pune on 6 December 1987. Overall, 42 single-seat MiG-29 fighters and six twin-seat MiG-29UB trainers were delivered to India in 1986-1987. Those were taken by two IAF squadrons formerly operating MiG-21s. A second batch, consisting of two dozen fighters, was delivered in 1989; the aircraft entered service with another IAF squadron. During his July 1994 visit to Moscow Indian Prime Minister Narasimha Rao raised the question of further defence cooperation with Russia; a December 1994 contract envisioned deliveries of ten MiG-29SE upgraded fighters, including two more MiG-29UB twin-seaters. The aircraft were delivered to India in 1995 to replace MiG-23MFs of 223rd Sqn and bring the IAF's overall MiG-29 fleet up to 84.

In 1982 IAF obtained BVR combat capabilities with MiG-23MFs armed with R-23R medium-range air-to-air missiles

Today, the IAF still operates 30 MiG-23MFs (224th Sqn), around 60 MiG-23BN fighter-bombers (31st, 220th, and 221st Sqns), and 133 MiG-27MLs (2nd, 9th, 10th, 18th, 22nd, 29th, 51st, and 222nd Sqns), 26 twin-seat MiG-23UBs, four MiG-25RB reconnaissance aircraft, and one MiG-25RU trainer (102nd Sqn), 59 single-seat MiG-29 fighters and seven twin-seat MiG-29UB trainers (28th, 47th, and 223rd Sqns). Six MiG-23BNs and six MiG-27MLs are used by Tactical & Air Combat Development Establishment for combat pilot training purposes; another 16 MiG-23BNs have been upgraded for ECM missions.

India's MiG-27MLs are relatively young and haven't yet served out their service life; just like

Jaguars, they will remain in service until 2020. Therefore, the IAF currently considers corresponding upgrade measures, mainly to modernise MiGs' avionics. HAL plans to fit 40 MiG-27MLs with a mixed suite of Indian-, French-, and Israeli-made equipment. Russian MiG corporation and IAIA, in turn, offer their own MiG-27 upgrade programme. Another Russian proposal deals with enhancing the MiG-27's flight parameters through installation of a new power plant based on the AL-31F turbofan engine that powers fourth-generation Su-27 fighters.

The modified AL-31FN engine, which differs from the prototype in a bottom-located accessory box, was designed by MMPP Salut Moscow Machine Production Plant. Specialists of the plant claim that re-engining MiG-23s and MiG-27s is fairly feasible. Re-engined fighters will get an extra tonne of thrust, lose 200kg in weight, and offer a 10% increase in efficiency. As a consequence, their range and combat load capabilities will also be enhanced. Aircraft may be re-engined in squadrons.

It is also planned to upgrade India's MiG-29s and Mirage 2000s. The MiG-29 will get new radars, in-flight refuelling system, and RW-AE medium-range air-to-air missiles with active radar seeker. The IAF's Mirage 2000s were armed with Russian R-73 missiles in the summer of 1999, and may soon get RW-AEs. This is the first time Russian-made weaponry is used on modern Western fighters. India's MiG-21s, in turn, were fitted with French-made Magic short-range missiles, and IAF MiG-29s got Super 530D medium-range missiles. Dassault Aviation negotiates with India over Mirage 2000-5 deliveries. If the contract gets signed, Mirages will be built under license by Indian plants. Still, the IAF's major upgrade efforts in the coming several years will be concerned with Russian-made super-manoeuvrable multirole Su-30MKI twin-seat fighters.

MiG-29s became the most powerful fighters of the IAF in the late 1980s. Since 1987 they were introduced in service with No 28, 47 and 223 Sqns. KB724, KB736 and KB713 shown in the picture belong to No 28 Sqn while KB707 – to No 47 Sqn

Sukhoi's breakthrough to Hindustan

On 27 September 2002, the first ten Su-30MKI fighters were handed over to the IAF at the Pune Air Force Station. This marked a new era in India's fighter aviation. With New Delhi attaching special importance to the event, the handover ceremony was attended by Indian Defence Minister George Fernandes and Air Chief Marshal Srinivasapuram Krishnaswamy, the Chief of Air Staff.

Russia was represented at the ceremony by Vladimir Pakhomov, deputy Director General of the Rosoboronexport State Corporation, IAIA President Aleksei Fyodorov, Sukhoi Director General Mikhail Pogosyan, and top managers of several other enterprises.

George Fernandes commented on the event in a political plane, "Today's ceremony demonstrates close – and absolutely new – defence relations between India and Russia, relations aimed exclusively at security of this country."

After demonstration flights of the new fighters, Air Chief Marshal Krishnaswamy stated that "the Su-30MKI fighter's service entry with India's military aviation is a fait accompli" and referred to it as "a great contribution to the IAF's long-term modernisation and re-equipment plans".

The contract for delivery of 40 Su-30MKIs was signed in Irkutsk on 30 November 1996. Already in the spring of 1997 New Delhi received eight Su-30Ks – although different in appearance from Su-30MKIs, these fighters were well-suited for familiarising Indian pilots with the new fighter type. On 11 July 1997 these eight machines were officially added to the IAF's inventory at the Pune Air Force Station. An article in this issue discusses the progress with the Su-30MKI programme, so here we will only note that hold-ups in Su-30MKI deliveries forced the parties in the autumn of 1998 to sign a follow-on agreement on purchases of ten more Su-30Ks, which arrived in India in 1999; the first ten Su-30MKIs were only delivered in the summer of 2002.

Irkut Corporation (IAIA's new name since late 2002) will deliver two more Su-30MKI batches to India: 12 fighters in 2003 and ten in 2004; only the latter batch will fully comply with India's technical requirements. After this, 18 Su-30Ks and 22 Su-30MKIs supplied earlier will be retrofitted to meet the contract terms.

One of the 18 Sukhoi Su-30Ks received by India in 1997-99 and put in service with No 24 Sqn

The future mainstay of the Indian fighter aviation, the Su-30MKI

Along with importing Su-30MKIs, India will soon launch licensed production of these fighters. The corresponding contract was signed in Irkutsk on 28 December 2000 as part of an intergovernmental agreement between Russia and India. The contract defines the terms and conditions for licensed production of the Su-30MKI aircraft, AL-31FP engines, and associated avionics. India expects to build 140

fighters by 2017. New Delhi is obliged to abstain from selling these aircraft to third countries. All production-relevant technical documentation will be handed over to India. During the first stage of licensed production, Su-30MKI units and components will be supplied by Irkut Corporation, the prime contractor. In the long term India will gradually turn to local production of Su-30MKI componentry. The fighter's navigation system and multifunction colour displays will be purchased from French companies SAGEM and Sextant Avionique, and HUDs and ECM systems will be supplied by Israeli EL-OP Electrooptics Industries Ltd. (Elta). Certain avionics systems will be shipped from Russia with another part will be Indian-designed.

A servicing centre to be opened in the town of Hyderabad will coordinate production of electronics for licensed Su-30MKIs. Russia's Aerospace Equipment Corporation will be one of the major participants in the centre's operation. The centre will assist Indian enterprises in launching production of avionics, licensed production of aircraft radars, antenna assemblies, and automatic flight control systems. The possibility of delivering to India aircraft simulator systems to be designed and produced by Aerospace Equipment Corporation is currently under consideration.

In 2002 IAF received ten Su-30MKIs, now in service with No 20 Sqn

The IAF Command urged slight amendments to the plans for Su-30MKI licensed production in mid-December 2002. According to the new plan, the first Indian-assembled Su-30MKI must roll out already in 2004, and the last one, the 140th, is to be built in 2013.

Says Bharat Verma, a leading Indian military expert, "From the technology standpoint, the Su-30MKI project has no analogues in the history of defence cooperation between Russia and India. Its implementation will bring the engineering capabilities of Indian and Russian aircraft industries closer together in all respects, from design techniques to production technologies."

Mr. Verma notes that over 600 Russian subcontractors and virtually all resources of HAL are employed for this project, which can therefore be referred to as a superproject. He adds, "After we have attained positive results with Su-30MKI production we can face more complex matters in the most critical national programmes."

According to Mr. Verma, India is vitally interested in the possible outcome of Russia's work to create a fifth generation aircraft. "This task requires concentration of enormous financial and technological resources. Such a prospective programme complies with the interests of strategic partnership between our two countries," he says.

As many as 18 Su-30Ks delivered to India in 1997 and 1999 currently serve with the IAF's 24th Hunting Hawks Sqn, and the ten Su-30MKIs that arrived in 2002 formed the backbone of another IAF unit, 20th Sqn. The two squadrons are based at Pune.

Russian helicopters for India

India's contemporary fleet of military helicopters is largely based on Russian models. It currently includes 68 Mi-8 and 108 Mi-17 transports, 20 Mi-25 and 39 Mi-35 combat transport helicopters, 15 Mi-26 heavy-lift transports, five Ka-25 ASW helicopters, and 18 Ka-28 ASW helicopters.

The first mass deliveries of Soviet-made helicopters to India started in the early 1960s, when New Delhi purchased multirole Mi-4 transports from Moscow. India ordered the first ten Mi-4s in late 1960, after a high-altitude comparative testing programme of the Mi-4 and newest Western-made rotorcraft makes in the Himalayas. The ten Mi-4s entered service with the IAF's 199th Helicopter Unit in 1961, and already in early 1962 India ordered another 16 machines. More orders followed in 1963-1964 and 1966, eventually bringing the IAF's Mi-4 fleet up to 121 machines. These helicopters had been in service for a fairly long time, before they were replaced by advanced Mi-8s and later by Mi-17s.

Today, multirole versions of the Mi-8 family is the most widespread helicopter type in India's aviation. The Indian Armed Forces alone operate over 150 such helicopters: in the IAF's 1st Sqn and also in Helicopter Units No 105, 107, 109, 110, 111, 112, 117, 118, 119, 120, 121, 122, 128, 129, 130, 151, 152, and 153. Forty of these helicopters are the latest Mi-17-1V versions recently delivered from Kazan Helicopters in three configurations, including 30 helicopters with the ramp instead of the cargo door.

Mi-8s, Mi-17s, and their modifications are also used by Indian civilian operators. Pawan Hans Helicopter Ltd. operates three Mi-172s (a civilian variant of the Mi-17-1V) on cargo and passenger services to littoral oil and gas deposit development sites. Four Mi-172s are used for cargo operations by carrier Mesko Airlines, and so on. Eight Mi-8 deluxe versions (Mi-8S) are operated by 109th Helicopter Unit for transportation of high-ranking government and military officials.

Kamov Ka-28 is now the main ASW helicopter of the Indian Navy

India's most powerful helicopter is the Russian-built Mi-26 heavy-lift transport. The first Mi-26s were ordered in 1985, and shortly afterwards four machines entered service with 126th Helicopter Unit based at the Chandigarh Airfield of the IAF's Western Air Command. Soon after that India's Mi-26 fleet grew to ten helicopters, and New Delhi ordered several more.

Starting from the mid-1980s, India repeatedly purchased from the Soviet Union combat helicopters of the Mi-24 family. 125th Helicopter Unit formed at the Pathankot Airfield in May 1984 operated 20 Mi-25s (the export variant of the Russian Mi-24D). In April 1990 the Suratgarh Airfield-based 104th Helicopter Unit took 20 advanced Mi-35s (a variant of the Mi-24V). Soon afterwards the IAF's fleet of Mi-35s doubled.

Mil helicopters were followed by Kamov machines, which entered service with the Indian Navy. First it was seven Ka-25 deck-based ASW helicopters; those were replaced in May 1986 by a dozen advanced Ka-28 ASW rotorcraft (the export variant of the Ka-27). Kamov helicopters operated by the INAS 333 and INAS 339 squadrons were based both at Vizag and Mumbai Airfields and aboard five Project 61ME destroyers of INS Rajput type (the destroyers were built on the request from the Indian government at the Nikolayev-based Shipbuilding Yard, and were handed over to the Indian Navy between 1980 and 1988). These helicopters were planned to be used with aircraft groups of India's two aircraft carriers, the upgraded INS Vikrant and INS Viraat (the latter was purchased in 1987 from the UK). According to press reports, in 2001 India was negotiating with Russia over deliveries of six more Ka-28s. The Indian Navy is currently taking Ka-31 deck-based AEW helicopters.

Mil Mi-8, the most numerous medium transport helicopter in Indian aviation

Mil Mi-26 heavylifters serve with 126th Helicopter Unit of the IAF

India ordered four Ka-31s in 1999 to be deployed on INS Viraat and three Project 11356 frigates currently under construction in St. Petersburg. A February 2001 follow-on contract with Rosoboronexport stipulated the purchase of five more such helicopters. The first Ka-31 prototype built for the Indian Navy made its first flight on 16 May 2001, and tests of the two first helicopters under the contract were finished in September 2002, with their delivery scheduled for late 2002. Seven more Ka-31s will be delivered in the next several years. The helicopters will be built by the KumAPP Kumertau-based plant, while the Kamov company outside Moscow will fit them with avionics and other equipment.

Just like the IAF's warplanes, India's Russian-made army and naval helicopters require modernisation. This first of all goes for combat Mi-35s and transport Mi-26s operated by the Indian army aviation.

Rostvertol company, the manufacturer of Mi-35s and Mi-26s, launched an overhaul/reconditioning programme for a batch of India's combat helicopters in October 2002. Says A. Zhukov, head of Rostvertol's aircraft engineering service, "Under the contract, we will repair and partially upgrade four Mi-35s and one Mi-26 heavy-lift transport. Simultaneously with repairs we will extend the service life of these helicopters." The Mi-26 will be fitted with new flight/navigation equipment to enable operations on international routes. The helicopter will also get new loading/unloading accessories, gear. Simultaneously with Rostvertol's programme, India has had part of its Mi-35 fleet upgraded in Israel.

There are also plans to upgrade Ka-28s ASW helicopters of the Indian Navy. The machines may get a helicopter-borne version of the Sea Dragon search-and-track system developed by the St. Petersburg-based Leninets Holding on India's request. The system is designed for electronic, underwater, sea-surface, and air reconnaissance, and also for anti-air operations, target designation, and environmental monitoring.

India might purchase new Russian-designed helicopters in the long term. Kamov began active promotion of its Ka-50 and Ka-52 combat helicopters to the Indian market several years ago. Now that New Delhi has launched the indigenous ALH multirole helicopter programme, which includes a military armed variant, Kamov's offerings have been put on the back burner, but India might reconsider them at a later date.

Military transport aviation

The IAF currently operates 24 medium-range Ilyushin Il-76MD transports and 106 short-range Antonov An-32 transports, the backbone of India's military transport aviation.

India's first purchases of Soviet transport aircraft date back to the early 1960s. In late 1960, along with Mi-4 helicopters, India ordered 24 Ilyushin Il-14 piston-engined aircraft and eight Antonov An-12B turboprops from the Soviet Union to enhance the IAF's personnel/materiel airlifting capabilities due to the aggravated situation on the Indo-Chinese border in the Himalayas. The Il-14s were delivered in 1961 and remained in service until 1965.

The first An-12Bs arrived in India in March 1961 to replace aged Douglas C-47 Dakotas and Fairchild

In 1999-2001 India ordered nine Kamov Ka-31 AEW helicopters for its existing and future aircraft carriers and frigates

Three Tupolev Tu-124K VIP transports flew in India in 1960s-70s

Packets. A year later India ordered eight more An-12Bs, and July 1963 saw a new order for 25 such aircraft. By the late 1960s, two IAF squadrons were equipped with An-12Bs. In all, the Soviet Union sold India 65 An-12Bs, These aircraft had remained in service with the IAF before they retired in the early 1990s, to be replaced by Il-76 jets. Those An-12Bs which hadn't yet served out their service life were set up for sale.

Antonov addressed the IAF with An-32 upgrade proposals, which provided for installation of a new engine control system for the AI-20D Series 5 turboprop. Introduction of the "emergency power" feature will allow for an increase in aircraft's take-off weight from 27t to 28.5t and in payload weight from 6.7t to 7.5t. Service life tests and operational status checks run on Indian An-32s will enable low-cost extension of the aircraft's service life from 15 to 25 years. Preliminary estimates set the upgrade cost at $800,000 per airplane, whereas a new An-32 comes with a price tag of not less than $6 million. An Indian delegation visited Kiev in the summer of 2002 and promised to "respond to Ukraine's offer in the near future".

Simultaneously with An-32 deliveries the IAF started taking heavier Soviet-made Ilyushin Il-76MD jet transports to replace ageing An-12Bs. Produced by the Tashkent Aircraft Production Corporation, Il-76MDs can carry up to 42t of cargo to a range of 5,000km. India, which had never before possessed such giants, dubbed the airplane Gajraj (King Elephant). The first Il-76MDs were received by the IAF in 1985; 24 of them currently serve with 25th and 44th Sqns. According to our sources, two Il-76MDs were re-equipped for electronic reconnaissance missions.

Ever since the late 1980s India has been interested in special Il-76 derivatives, namely the Il-78 refuelling tanker and the A-50 AWACS aircraft. Media have it that in the early 2001 India ordered six Il-78MK tankers from the Tashkent Aircraft Production Corporation (TAPC). The IAF's demand for such aircraft increased as Su-30K and Su-30MKI fighters, fitted with in-flight refuelling system, started arriving in the country. Air Chief Marshal Krishnaswamy stated on 9 October 2002 that Il-78MK deliveries, which are scheduled for 2003, "will enhance the IAF's potential".

India's "affair" with purchases of Il-76-based AWACS aircraft has been dragging on for nearly 15 years now. In 1988 A-50 AWACS aircraft fitted with the Shmel (Bumblebee) radar system was shown to Indian specialists to possibly consider purchases of these aircraft. The proposed variant of the A-50 did not suit the IAF, since it failed to interact efficiently with India's air defences and provide target designation to IAF's contemporary fighters. As a result, New Delhi decided on developing an indigenous AWACS system to be based of the Avro 748 transport produced locally under British license. Two HAL.748 AWACS demonstrators were manufactured in the second half of the 1990s. After one of them had crashed, the IAF suspended the programme and again turned to the A-50 option.

Antonov An-32 Sutlej, the main transport horse of the IAF

Three Tupolev Tu-124K VIP transport jets built in the mid-1960s by the Kharkov Aviation Manufacturing Company were purchased by India to transport Defence Ministry and IAF top-brass and to be used as airborne headquarters. The IAF had operated these aircraft until 1981, when they were replaced by US-made Boeing 737 VIP variants.

The IAF's next large purchase from the Soviet Union in the interests of military transport aviation were Antonov An-32s. These aircraft were ordered in the mid-1980s to replace Dakotas, Packets, and DHC-4 Caribous operated by IAF squadrons. Powered by two AI-20D Series 5 turboprop engines each offering 5,180hp, An-32s could transport up to 6-7t of cargo, or 30 troops, or 24 casualties to a range of 2,200km and had a short-runway, high-altitude airfield deployment capability. According to different sources, starting from 1984 India took 118 to 124 An-32s built by the Kiev-based Aircraft-building Plant. These aircraft were locally dubbed Sutlej (a river in northern India). Over one hundred An-32s are still in service with the IAF's 11th, 12th, 25th, 43rd, 48, and 49th Sqns. Our sources claim that three An-32s were re-equipped at some point for air reconnaissance and aerial photography operations.

Due to extensive operation many An-32s have by now served out their service life. In September 2001,

Under a December 1999 agreement, the Russian Air Force assigned one A-50 to India for familiarisation flights. The aircraft arrived at Chandigarh airfield, Punjab State, in April 2000. A Russian crew was joined on board by Indian specialists to perform ten flights, up to 6h each. The Indian party was left generally satisfied with the aircraft's performance.

Observers set India's demand for A-50-type AWACS systems at six aircraft. Russia offers India the modified A-50EI variant with an Israeli-made radar sys-

Ilyushin Il-76MD Gajraj freighters are used in India for heavy-lift operations since 1985

Ilyushin Il-214 may become a prototype for the Indian MTA future transport

tem that much more corresponds to India's expectations. According to press reports, under a 2001 agreement India may order three A-50EI AWACS aircraft from Russia. The aircraft might be developed by the Beriev Aircraft Company from Tashkent-made Il-76TD airframes, powered by PS-90A turbofan engines, and fitted with the Israeli-made Phalcon radar system. While these aircraft are under development, construction, and testing, Moscow may lend New Delhi two or three standard A-50 AWACS aircraft, those currently in service with the Russian Air Force. Indian crews might fly these airplanes, fitted with the Shmel radar system, until new A-50EIs get available.

The IAF's major prospective programme in the interests of military transport aviation is linked to joint work with Russia in development of a prospective medium Multirole Transport Aircraft (MTA). This airplane might in the long run replace the IAF's fleet of An-32s. In accord with a decision signed in late 2000 between the Indian government and two Russian enterprises, Ilyushin and IAIA (now Irkut Corporation), the MTA will be a joint Russo-Indian project based on the prospective Russian Ilyushin Il-214T transport aircraft capable to carry 15t to 20t of cargo or 82 troops to a range of up to 2,500km at a speed of 850km/h. The power plant for this aircraft, whose take-off weight will be 55t, may consist of two Russian- or Ukrainian-made turbofan engines like the PS-9 or the D-436T, or two British-made BR170s. The MTA/Il-214T commencement protocol was signed on 6 June 2001. In June 2002 the MTA project was added to the ten-year programme of military technical cooperation between Russia and India.

Mr. Verma believes that "the MTA programme is one of the most prospective Indo-Russian aviation projects", and notes that the new Russo-Indian multirole transport aircraft will be developed by a joint team of designers, engineers, and managers representing HAL, Rosoboronexport, Ilyushin, IAIA, and a number of other enterprises. The first MTA demonstrator may be built in 2006. The initial project stage will cost around $300-350 million. India and Russia will finance the programme on a parity basis.

A joint venture will be established to implement the project. HAL chairman Nalini Ranjan Mohanti says no budget funds will be allocated for the MTA project, so it is important to the partners that the IAF guarantee purchases of the aircraft. Mr. Mohanti says the IAF "has made it perfectly clear" that it needs 35 MTA-type airplanes (other sources claim the Indian Defence Ministry is ready to order 50 aircraft with an option for 100 more). Apart from the military transport variant, the MTA/Il-214T will be produced in the Il-214-100 passenger version.

Naval aviation

Aviation of the Indian Navy currently operates three Ilyushin Il-38 medium-range ASW aircraft and eight long-range Tupolev Tu-142ME ASW aircraft. India and Russia are the only countries that have such airplanes in their armoury.

India ordered five Il-38s from the Soviet Union in early 1976; already on 1 October 1976 the first three aircraft were delivered. They were shortly followed by two more Il-38s. All the five aircraft entered service with the INAS 315th Sqn based at the Goa-Dabolim airfield. On 1 October 2002 two INAS 315 Il-38s collided over the western coast of India during a formation flight. The remaining three Il-38s, which have been operated for over 25 years, are to be repaired and upgraded in Russia. According to some sources India ordered two Il-38s from the Russian Naval Aviation inventory to pay its damages.

The Indian Defence Ministry signed the upgrade contract for the five Il-38s with Rosoboronexport and Ilyushin in September 2001. The first Il-38 arrived to Russia on 29 March 2002. It will get a new search-and-track system and advanced ASW equipment. Under the contract terms, the last upgraded Indian Il-38 is to take off for its first flight in the first quarter of 2005.

In 1986 India purchased from the Soviet Union eight long-range Tu-142ME ASW aircraft (the export variant of the Soviet Tu-142MK with the Korshun (Kite) search-and-track system). These airplanes, which possess a unique range and patrol endurance of nearly 17h, were built at Taganrog-based TAVIA plant on request from the Indian Navy and were delivered to India in April 1988. They entered service with the Arrakonam Airfield-based INAS 312th Sqn.

Like the Il-38s, the Indian Navy's Tu-142MEs may shortly be upgraded in Russia. The press has it that the upgrade contract for all the eight aircraft may be signed already in the mid-2003, with the TAVIA Plant posing as the prime contractor. Upgraded Tu-142MEs will feature an improved search-and-track system, a upgraded navigation system, a new weapons control system, etc.

The Indian Navy may shortly adopt the modernised Admiral Gorshkov aircraft carrier and deck multirole fighters to be purchased from Russia. After the retirement of INS Vikrant in the second half of the 1990s (the vessel was received in 1961 from the UK and was upgraded in 1984 to accommodate Sea Harrier VTOL aircraft), India was left with only one aircraft carrier, INS Viraat (formerly HMS Hermes), received from the UK in 1987, and deck Sea Harriers. Now that India's naval doctrine envisions operation of two aircraft carriers, simultaneously with development of the indigenous prospective ADS vessel, New Delhi has for the past five years been negotiating with Moscow over purchase of the Project 1143.4 Admiral Gorshkov, a discarded heavy aircraft carrier formerly operated by Russia's Northern Fleet.

If India eventually gets the vessel, the Admiral Gorshkov will be repaired and upgraded by the Russian Sevmashpredpriyatie shipyard to be downgraded to a classic aircraft carrier (in particular, the anti-ship missile system will be dismantled). The carrier will additionally be fitted with ramp and arresting gear to provide for take-off and landing of standard-design (non-VTOL) fighters.

According to press reports, the Admiral Gorshkov may come with MiG-29K and MiG-29KUB deck fighters

Indian long-range ASW aircraft: Tupolev Tu-142ME from the INAS 312 Sqn (top) and Ilyushin Il-38 from the INAS 315 Sqn (bottom). Both types will be overhauled and upgraded in Russia in the nearest future

to be developed by the MiG Russian Aircraft Corporation from production MiG-29s. These fighters may incorporate separate units sampled on the MiG-29K prototypes that was tested in 1989 through 1991 on the Admiral Kuznetsov aircraft carrier, and also modern equipment and weaponry used with upgraded MiG-29SMT fighters. India is expected to purchase up to 46 MiG-29Ks and MiG-29KUBs. The upgraded Admiral Gorshkov will be able to accommodate 24-30 such fighters, together with two Ka-31 AEW rotorcraft, two Ka-28 ASW helicopters,

and two search and rescue helicopters. The remaining MiG-29Ks may be used for ground training of Indian naval pilots, and then adopted, at some later point, on the future indigenous ADS carrier.

However, taking into consideration that the contract for the carrier and the aircraft is still nowhere near the signing point, some experts tend to believe that India has not yet made up its mind as to what type of deck fighters to purchase, and is considering the possibility of outfitting the carrier with Su-33s. Unlike MiG-29Ks, these deck fighters serve with the Russian Navy's aviation and have been tested by nearly ten years of actual deck service. The main drawback of this option is that the Sukhoi fighter is larger than the MiG, which may reduce the number of carrier-deployed aircraft by approximately 1.5 times. Nevertheless, other analysts believe that, despite the lower numbers, the efficiency of a Su-33 carrier-deployed wing (if fitted with upgraded equipment and state-of-the-art precision-guided weapons) may be even higher than that of a MiG wing. India is expected to make the final decision in 2003.

Confluence of the Moskva River and the Brahmaputra

One of the most significant Russo-Indian defence projects is the development and production of the supersonic BrahMos anti-ship missile. Russian and Indian designers are developing the project on the basis of the Yakhont (Ruby) anti-ship missile created by the NPO Mashinostroeniya Federal Scientific and Production Centre in Reutov, Moscow Region. The programme, which includes land-, sea-, and air-based versions of the missile, is being implemented by the BrahMos joint venture (the BrahMos abbreviation stands for a merger of the first syllables in the names of the Indian and the Russian rivers, the Brahmaputra and the Moskva River) established by NPO Mashinostroeniya and India's Defence Research & Development Organisation (DRDO). The work on the programme was initialled by an intergovernmental agreement signed in February 1998. The contract for development of the BrahMos missile was concluded in July 1999.

With a launch weight of around 3,000kg and a warhead weighing 200-300kg, the BrahMos (PJ-10) anti-ship missile is designed to destroy large surface objects at ranges of up to 290km. The missile proceeds to the target at a midcourse altitude of 14km above sea level and a terminal altitude of 10-15m, at a speed of M=2.8. The missile is powered by a midcourse ramjet and a powder booster. The missile's major merits are supersonic speed at all flight stages, multiplicity of trajectories, highly efficient guidance system, and low radar cross-section.

The missile can be launched from coastal fixed and mobile wheeled launching systems, and also from surface vessels. Designers also work to create a modification to be deployed on Akula Class submarines that the Indian Navy may purchase from Russia. The airborne BrahMos-A variant is under development specially for deployment on aircraft; with a launch weight reduced to 2,500kg. This version is meant for deployment on the IAF's Su-30MKI fighters and the Indian Navy's long-range Tu-142ME ASW aircraft.

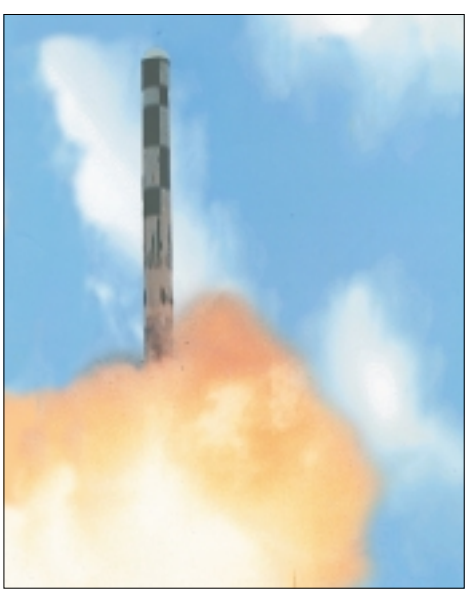
The first successful test of the BrahMos missile from a land-based vertical-launch system was held at the Indian testing area of Chandipur, Orissa, on 12 June 2001. On 28 April 2002, the same test area hosted a second successful launch, and the first test aboard INS Rajput (a Russian-built Project 61ME destroyer) was scheduled for June 2002. The BrahMos testing programme is planned to be accomplished by late 2003 or early 2004, after which production of the missile will be launched in India for her own Navy and later on, possibly, for export to third countries.

Other programmes

Of late, the headlines have been full of reported accidents and crashes involving IAF MiG-21 fighters. The majority of these flight accidents, however, have nothing to do with the aircraft's operational status. Thus, during a 14 November 2002 training flight a MiG-21U crashed near the town of Badgodr, 8km off the base. The crash was caused by the pilots' mistake: the aircraft hit power lines while flying too low. In all, during 2002 the IAF lost 11 MiGs to flight accidents; four of the aircraft were trainers.

Nevertheless, Indian Defence Minister George Fernandes dismissed rumours about the decision to ground MiG-21U trainers. At a press conference in Vijayawada, Andhra-Pradesh, Mr. Fernandes said that an expert group consisting of Indian and Russian specialists had performed technical evaluation of the IAF's MiG-21 fleet and concluded that the aircraft are absolutely airworthy.

The cause of all these recent accidents is likely to lie with the fact that young Indian fighter pilots find it difficult to learn to fly a supersonic fighter after practice on obsolete HJT-16 Kiran aircraft currently used by the IAF for pilot training. The IAF Command is aware of this problem. Simultaneously with development of the indigenous prospective HJT-36 jet trainer, whose first flight was scheduled for late 2002, India has long been negotiating with the UK over purchase of 24 British Hawk 100 trainers with a prospect of 42 more aircraft licensed production. Last time the issue was raised in October 2002, during talks between British Prime Minister Tony Blair and his Indian counterpart Atal Bihari Vajpayee. London wants over 1 billion pounds (around $1.5 billion) for the airplanes, whereas New Delhi takes such a sum to be too high.



Test launch of the BrahMos antiship missile demonstrator

In the light of these hold-ups Russian companies took the chance to offer India their own trainers. MiG was the first in line with its new project, the MiG-AT aircraft. Negotiations went on for several years. Just like with the Hawks, India was apparently unhappy with the high price of the MiG-AT. Another reported drawback of MiG's offer was that the new trainer is not yet adopted by the Russian Air Force. In this situation, Rosoboronexport in 2002 chose to focus efforts on marketing in India the Yak-130 prospective trainer developed by the Yakovlev Design Bureau. By request from the Russian Air Force, production of this aircraft was launched in 2002 at the Nizhny Novgorod-based Sokol Aircraft Plant. The Yak-130 appears to have much better chances in India because it is already ordered by the Russian Air Force; also, the Sokol Plant has long-standing relations with Indian aircraft engineering companies established during the programme to upgrade the MiG-21bis fighters.

On 15 August 2002, Ilya Klebanov, co-chair of the Russo-Indian Intergovernmental Committee on Military Technology Cooperation, officially requested India's permission for Russia to participate in the tender on a combat trainer. On 9 December 2002, Mikhail Dmitriyev, deputy Russian Defence Minister and chair of the Committee on Military Technology Cooperation, told The Hindustan Times that "Russia is ready to sell India several nuclear-powered submarines (Akula Class) and long-range bombers (Tu-22M3), but the deal may be landed only on condition that India additionally purchases training aircraft," apparently meaning Yak-130s. "We are intent on concluding a corresponding agreement by the summer of 2003," added Mr. Dmitriyev.

The possibility of leasing several Tupolev Tu-22M3s from Russia has been discussed in India for several years. Media report that in October 2001 the parties reached a principal agreement on deliveries of four such aircraft. However, the issue is apparently still unsettled. If the deal takes place, India will become the first foreign country to get these aircraft, which will constitute a good deterrent against its potential adversaries.

Andrei Nikolayev, chair of the Russian Duma's defence committee, believes Russia takes steps towards a new security system in developing its strategic partnership with India. Mr. Nikolayev said prior to a November 2002 visit to India by a Russian parliamentary delegation, "This (security) system is an alternative to the one being developed by the US, but we are not keen to confront America. We do not make friends against anybody, we merely care for national security." Mr. Nikolayev opined that "we should give up direct arms trade and instead launch joint production of military hardware to promote it to the international arms market". This is the essence of future Russo-Indian cooperation in military aviation sphere – cooperation with a glorious past and no less greater prospects.

Andrei FOMIN,
Andrei YURGENSON

DECK FIGHTER TRAINING BEGINS ON LAND

10 years ago, on the spring of 1993 the first four production Su-33 deck fighters were delivered to the Admiral Kuznetsov aircraft carrier of the Northern Fleet to form the aircraft group of the Russia's first heavy aircraft carrier fitted for deployment of standard-design supersonic fighters. The Su-33s were adopted by two squadrons of the 279th Shipborne Fighter Regiment of the Air Force attached to the Northern Fleet.

Shortly afterwards regiment pilots started flights from the Severomorsk-3 airfield. Pilots from the Crimea led by Colonel Timur Apakidze constituted the backbone of the regiment. Training pilots to land on the carrier without prior ground training would be very hazardous, and the CIS-only simulation facility, the Nitka land testing and training complex, was in Ukraine.

The problem was not solved until 1994, when the two countries signed an intergovernmental agreement on the Nitka complex lease. In July 1994 the ten best pilots of the 279th Regiment arrived at Nitka. Rational flight scheduling and proper coordination of all services and organizations involved helped the Russian pilots to make the best of the short lease period (which lasted only one month). The first ten pilots of the Northern Fleet that took a ground course in deck landing were Colonel Apakidze, Deputy Division Commander; Colonel Chibir, Division Chief for Flight Safety; Colonel Bokhonko, Commander of the 279th Regiment; Lieutenant Colonel Kozhin, Squadron Commander; Lieutenant Colonels Dubovoi and Kochkaryov, Deputy Squadron Commanders; Lieutenant Colonel Ryzhov and Major Podguzov, Unit Commanders, and Captains Abramov and Kuznetsov. In August and September 1994 they all learned how to take off from and land on an aircraft carrier.

Thus began regular service operation of deck Su-33 fighters. The Northern Fleet had by then received 26 production aircraft from the Komsomolsk-on-Amur plant. In 1995, the first squadron of the 279th Regiment was attached to the so-called permanent readiness forces of the Northern Fleet. This was followed by the Admiral Kuznetsov's oceanic cruise to the Mediterranean with Su-33s on board, by tactical flight exercises, and by training of young deck pilots...

...A warm, cloudless July night at the Crimean airfield of Saki. Muffled rumbling of aircraft engines reaches the ear. Lights are moving in the dark: it's the first fighter taxiing for take-off. It tarries on the runway for a while, its engines revving up, then follows a short run and – here it goes, higher and higher, with an immediate right turn to go around and go back in for an arrested recovery.

This is a typical night flight routine for pilots of the 279th separate shipborne fighter regiment at the Nitka training complex. In July and August 2002 Colonel Rasskazov, Regiment Commander, organized another course of training in the Crimea for his subordinates. Pilots of the Northern Fleet regularly go to the Nitka complex, although preparation for training takes up much time and finance: Nitka belongs to Ukraine, and coordination of all training-related issues is a difficult task.

Under an agreement between the Ukrainian and Russian Defence Ministries, Russian deck fighter pilots can now go train at Nitka every year. In the previous several years, flights in the Crimea would be the only possibility for Russian naval pilots to fly, because all the scarce fuel reserves were designated exclusively for training at Nitka. These days Russian pilots fly more regularly and can hone their skills at their home airfield in

Severomorsk. The regiment pilots also fly L-39 trainers of the Ostrov, Pskov-Region Naval Aviation Combat Training and Crew Conversion Centre. Thus, each pilot in the regiment has enough flight hours at his disposal to drill tasks that do not require Nitka's exclusive capabilities.

We should remark that the Nitka complex is kept in a perfect state thanks to its commander, Colonel Pleshkov. His subordinates offer professional support to Russian pilots and do a really hard work of maintaining the complex. Last summer was the first time that Russian pilots had absolutely no problems with fuel during their training at Nitka.

For an outsider flights at Nitka may appear very tiresome: fighters take off, go around, approach, do a quick touch-and-go, and repeat it all over again for many, many times in a row.

But each aircraft is closely watched by dozens of specialists, who analyse every flight stage and clear the fighter for arrested recovery. And such landings are much different from ordinary landings on ordinary airfields. With a 4° glide slope, a deck fighter maintains minimum airspeed and lateral divergences, and the pilot must direct the aircraft to a small runway section, just 36m in length, to hook up to one of the arresting cables stretched across the deck. Such a steep approach implies increased loads on the landing gear, on the airframe, and on the pilot: progressive deceleration (an arrested aircraft only rolls 90-100m to a complete stop) results in great supine G values. Only highly professional pilots can land on an aircraft carrier.

Last summer's day and night flights at Nitka enabled each of the Russian pilot to perform dozens of approaches and arrested recoveries and drill ski-jump take-offs.

The pilots were trained by experienced aces of the regiment, test pilots, and inspector pilots of the Department for Naval Aviation Combat Training.

During the training programme the pilots performed the record-setting number of flights for the past several years and honed their combat and special skills.

Late in the summer of 2003 the Admiral Kuznetsov is expected to leave for another cruise; prior to that Russian Su-33 pilots will once again train in the Crimea.

Viktor DRUSHLYAKOV
Photos by the author

SU-30MKI PROGRAMME

AND SUKHOI'S INTERNATIONAL COOPERATION

India expressed her interest in procuring the Su-27 family fighters in the mid-1990s. The Indian Air Force (IAF) has traditionally operated a great variety of Soviet-produced aircraft, including several modifications of the MiG-21 fighter, the MiG-23MF and the MiG-29 fighters, as well as the Su-7BMK and the MiG-23BN fighter-bombers, the MiG-25RB high-speed/high-altitude reconnaissance bombers, etc. Moreover, in the 1980s-90s India undertook licensed production of the MiG-21bis and the MiG-27M. The Russian MiG-29 and the French Mirage 2000 were the most sophisticated fighters in service with the Indian Air Force in the early 1990s. Trying to boost further development of the Air Force and expand its combat capabilities, the Indian authorities decided to shift their focus towards new fighters, developed by the Sukhoi Design Bureau.

The Indian side expressed its interest in the upgraded two-seater, advertised by Sukhoi since 1993 as the Su-30MK, i.e. the aircraft, which besides a two-man crew differed from the Su-27SK series production export version in the following features: an increased range and endurance due to the in-flight refuelling system, as well as formidable armament, including air-to-surface precision guided munitions. The Irkutsk Aviation Industrial Association (IAIA), now known as Irkut corporation, which had extensive experience in co-operating with India insofar deliveries of the MiG-23UB combat trainer fighters and licensed production of the MiG-27M fighter-bombers were concerned, was the major promoter of exporting the Su-30MK to India. The initial batch of aircraft was supposed to have been shipped to India from Irkutsk as soon as the contract had been signed. At first, the customer was to have received standard production Su-30K fighters without new avionics and armament (IAIA had already launched the Su-30 version to be fielded with the Russian Air Force into series production by that time), but then, following corresponding improvements, Su-30MK multirole aircraft could be delivered.

However, in the course of negotiations the Sukhoi Design Bureau suggested that India should not limit its capabilities to the export version of the Su-30MK and should procure an aircraft, which featured considerably higher combat capabilities. These combat capabilities were defined by a number of design solutions tested or being tested on the Su-27M, including an improved aerodynamic configuration with canards, the new fly-by-wire system, as well as a power plant with thrust vector control nozzles. In addition to that the aircraft was supposed to be fitted with a phased array radar. Thus, India would be able to field a fighter with unrivalled manoeuvrability and combat capabilities. By the way, Russia did not have a mass production aircraft like that either.

The super-manoeuvrable multirole fighter, based on the Su-30MK, was yet to be developed. Nevertheless, India was quite upbeat about the proposal and agreed to finance design and development of the special Indian Flanker version, designated the Su-30MKI (I standing for Indian), and wait for the aircraft to be developed and tested.

At the same time, the Indian side put forward a number of additional requirements. The main requirement demanded that the fighter's avionics should be internationalised, i.e. along with Russian-produced systems the Su-30MKI was to be fitted with French, Israeli, and Indian components. The navigation, the display system, and the ECM suite were to be produced by foreign states, while the aircraft computer system was to be built around Indian CPUs.

The programme was planned to be carried out step by step for Indian pilots to master the new fighter as soon as possible. At the first stage they were supposed to get and learn to fly production Su-30Ks, and then as new systems and equipment were mastered, India would start receiving aircraft, which would gradually resemble the final design of the Su-30MKI. When the contract was fulfilled, aircraft of the initial batch were to be upgraded to the level of the Su-30MKI.

This approach was stipulated in the contract, signed by the Indian side, the Irkutsk manufacturer and the Sukhoi Design Bureau and brokered by the Rosvoorouzhenie State Enterprise in Irkutsk on 30 November 1996. The $1.8 billion contract envisioned delivering 40 aircraft in four batches to India in 1997-2000. In 1997 the customer was to get the initial batch of eight Su-30Ks, in 1998 - eight aircraft with upgraded avionics, in 1999 - 12 aircraft with improved airframes and new avionics, and finally in 2000 - 12 Su-30MKI aircraft, fitted with thrust vector control engines. Along with the aircraft India was also to get the following armament: the R-27ER1/ET1, the R-73E, and the

RVV-AE (export version of the R-77) air-to-air missiles, as well as the Kh-29T, the Kh-31A, and the Kh-59ME air-to-surface missiles. Starting from 2001 aircraft of the initial batch were to be upgraded to the level of the Su-30MKI of the last batch, while the Indian HAL Company was promised a feasibility of launching licensed production of the Su-30MKI at its plants.

In the spring of 1997 Antonov An-124 Ruslan military transports ferried the first eight Su-30Ks from Irkutsk to India in four flights in strict compliance with the set timeframe. On 11 July 1997 the official ceremony of fielding the aircraft with the Indian Air Force took place at the Pune airbase. The new fighters entered the inventory of the IAF's 24th Hunting Hawks Sqn.

In the meantime, the Sukhoi Design Bureau assembled the first prototype, featuring the airframe and the power plant similar to that of the Su-30MKI fighter. Test pilot Vyacheslav Averyanov took the aircraft named Su-30I-1, or T10PMK-1, based on series production Su-30 fighter, side number 56, for its maiden flight on 1 July 1997. Later on, having been repainted, the aircraft received side number 01. Main improvements, introduced to the first Su-30MKI prototype, consisted in modifying the aerodynamic configuration (introduction of the canards and corresponding changes to the wing leading edge root extensions) and installing the upgraded SDU-10MK fly-by-wire system, as well as fitting the aircraft with the AL-31FP thrust vector control engines.

The AL-31FP (product 96) engine differed from the series production AL-31F (product 99) in that it was equipped with a hinged nozzle, swivelling within a sector of ±15 degrees. The nozzles swivelling axis were deflected by 32 degrees from the vertical plane of symmetry, which allowed the aircraft to get not only a vertical, but also a lateral thrust vector component, given differential deflection of nozzles of both engines. In addition to the automatic thrust differential alternation capability of both engines (the so-called different thrust control) it also enabled the aircraft to be controlled in all planes at extremely-low and zero airspeeds, when conventional aerodynamic controls were not effective. The thrust vector control system on the Su-30MKI is integrated into the aircraft fly-by-wire system and does not have any separate control knobs, but when necessary, it can be completely deactivated with the nozzles set in the neutral position.

First prototype Su-30MKI (aircraft No 01) in a test flight with bomb ordnance

The thrust vector control system, the innovative aerodynamic configuration, and the efficient fly-by-wire system provided the Su-30MKI with unique manoeuvrability. Test pilot Averyanov mastered such aerobatics on the aircraft as no other aircraft in the world is capable of carrying out. In early December 1998 he demonstrated his aerobatics on Su-30MKI No 01 at the Aero India 98 air show in Bangalore, enthusing spectators. Similar demonstration was slated for the Le Bourget air show, held the following June, but on the eve of the show, on 12 June 1999, Su-30MKI No 01 had an accident, caused by an error of the crew. Vyacheslav Averyanov and navigator Vladimir Shendrik managed to successfully eject from the aircraft.

By that time two prototypes had been participating in the Su-30MKI test programme: in addition to the first prototype, the second one, Su-30MKI No 06, was derived from the T10PU-6 aircraft in 1998, which in turn had become the second Su-27PU (Su-30) prototype in 1988. It made its maiden flight on 23 March 1998. It was on this very aircraft that Averyanov completely righted himself in August 1999 two months after the crash in Paris by splendidly carrying out the demonstration flight, intended for Le Bourget, at the MAKS '99 air show in Zhukovsky near Moscow.

When the contract was signed, the Su-30MKI prototypes were supposed to have embarked on testing a new international avionics suite as early as 1997. However, the customer could not make up his mind as to the final composition of the avionics package. As a result the contract deadline was shifted, while Su-30MKI airframes, already produced in Irkutsk, found their way to the IAIA workshop, awaiting avionics. Given this environment, the deliveries timeframe was decided to be revised: now the initial batch of eight Su-30Ks, delivered to India, was to be followed by

Second development aircraft, Su-30MKI No 06

final versions of the Su-30MKI without any intermediate modifications starting from 2000. At the same time in the autumn of 1998 the agreement on delivering an extra batch of 10 production Su-30Ks (in addition to the 40 aircraft, stipulated in the 1996 contract) was signed. These aircraft, which by that time had been assembled by IAIA and fitted with Russian avionics, arrived in India in 1999.

The final decision on the composition of foreign components to be incorporated into the Su-30MKI avionics suite was taken only in March 1998. In compliance with the fighter's layout, approved by the customer, the following Russian systems constituted the backbone of its weapons control system: the Tikhomirov NIIP-designed Bars (N011M) phased array radar (produced by the GRPZ Ryazan State Instrument-making Plant), the OLS-30I optronic sighting system (produced by the UOMZ Urals Optical Mechanical Plant), and the Sura-K helmet-mounted target designator (developed and produced by the Ukrainian Arsenal plant).

The Su-30MKI data presentation system is supplied by French Sextant Avionique. It comprises the VEH3000 head-up display, six 127x127mm (5x5in.) MFD55 colour multifunction LCDs, and one 152x152mm (6x6in.) MFD66 display, with three small displays quartered in each cockpit and a large one housed only in the rear cockpit. In addition to that the same company is responsible for fitting the aircraft with the Totem INS/GPS inertial and satellite navigation system.

The Su-30MKI computer system is based on Indian-produced digital processing units, developed by the DRDO state company within the framework of the Vetrivel programme. The ECM system of the aircraft is to be supplied by Israel and to be based on the Elta EL/M-8222 jammer. In addition to that the Su-30MKI is to be fitted

Three pre-production Su-30MKI fighters, from top to bottom: No 05, 04, and 02

with the Rafael Litening optronic targeting and navigation pod in order to provide the aircraft with the all-weather, round-the-clock air-to-surface capability. The rest of the avionics is Russian-produced. The RPKB Ramenskoye Instrument-making Design Bureau is responsible for integrating all components of the international avionics package of the fighter.

The Bars phased array radar, facilitating electronic beam scanning both in azimuth and elevation, is one of the primary features of the Su-30MKI avionics suite, which provides it with unique combat capabilities. A hydraulic actuator provides the phased array with an extra mechanical azimuth correction in order to increase the radar's horizontal surveillance sector. In the air-to-air mode the radar is capable of simultaneously tracking at least 15 targets, while still carrying out surveillance, simultaneously engaging four targets in a long-range missile combat, detecting the number of targets in a dense target formation, and designating the target acquired. In the front hemisphere the radar's detection range of a fighter totals 150km.

In the air-to-surface mode the radar is capable of detecting and tracking ground and sea surface targets in the map-making mode with a low (300x300m), medium (30x30m), and high (3x3m) resolution; detecting and prioritising moving ground targets; carrying out a low-altitude terrain-hugging flight; and designating the target acquired. The radar is capable of detecting a group of tanks at a range of over 40-50km, while a bridge or a destroyer at a range of 120-150km. The electronically controlled beam of the Bars radar allows the air-to-air and air-to-surface modes to be synchronised: for instance, the radar is capable of tracking a ground target, while simultaneously carrying out air surveillance or engaging an air target.

RVV-AE active homing fire-and-forget medium-range air-to-air missiles and R-73E dog-fight missiles, as well as R-27ER1 semi-active homing medium-range missiles constitute the mainstay of the Su-30MKI's armament suite. In order to carry out pinpoint strikes against ground targets the aircraft may be armed with Kh-29T (TE) TV-guided missiles, Kh-59ME TV-command guided medium-range missiles, and KAB-500Kr guided bombs, while Kh-31A anti-ship missiles may be relied on to kill naval targets. In addition to that, in the future, the aircraft may be fitted with the BrahMos anti-ship missile, being developed by the Russian-Indian joint enterprise of the same name and based on the Yakhont (Ruby, Sapphire) anti-ship missile. There have also been some reports that the Su-30MKI is intended to be armed with Israeli Popeye air-to-surface missiles fitted with various guidance systems.

In September 2000, following the final agreement with the customer on composition of the avionics suite and delivery of operational AL-31FP power plants, IAIA assembled the first pre-production Su-30MKI, side No 05 (serial No 19-07). On 26 November 2000 test pilots Vyacheslav Averyanov and Roman Kondratyev took the aircraft for its maiden flight. On 15 February 2001 it was joined by the second pre-production aircraft, side No 04 (serial No 20-06), while in April of the same year they were followed by the third one (side No 02). Another pre-production aircraft side No 07 was manufactured to replace Su-30MKI No 01, which had been lost in Paris, while No 03 (serial number 19-06) was sent to the SibNIA Siberian Scientific-Aeronautical Research Institute for static tests. Thus, the Su-30MKI flight tests programme saw participation of one prototype (side No 06) and four pre-production aircraft (side Nos 02, 04, 05, and 07). Besides, other aircraft were involved in the tests as well. For instance, the Bars radar was tested on the T10M-12 (Su-27M side No 712) single-seat aircraft in addition to the Su-30MKI, while some other avionics systems were tested on Su-30 No 01-01 (one of the first Su-30MK demonstration aircraft with side No 603).

Su-30MKI instrument panels fitted with French-made LCDs: front cockpit (top) and rear one (bottom)

In late 2001 the first production Su-30MKI, designed to be delivered to the customer, was assembled and made its maiden flight in Irkutsk piloted by the crew of Sergei Bogdan and Leonid Smely. The first batch, comprising ten production Su-30MKIs, was delivered to India by An-124 Ruslan military transports in June-August 2002, and on 27 September of the same year they were

Sukhoi Su-30K from the IAF's No 24 Sqn

fielded with the Indian Air Force at an official ceremony, held at the Pune airbase and attended by the Indian Defence Minister.

The 32 Su-30MKI fighters, stipulated in the contract, are expected to be delivered to India by 2004 (the second batch, comprising 12 aircraft, is planned to be delivered in 2003, while in 2004 the last ten fighters will arrive in India). Right after that the HAL plants will launch licensed production of the Su-30MKI. The contract with this end in view was signed in Irkutsk on 28 December 2000; it envisions building 140 Su-30MKI aircraft in India by 2017. Along with the airframes the HAL enterprises will also manufacture avionics suites and AL-31FP turbofans for them with the assistance of Russian companies (as opposed to the Su-27SK's licensed production in China, with all power plants delivered from Russia).

Indian Su-30MKI with its full combat load: 250kg bombs could be seen under the fuselage and air intake ducts while R-27ER1/ET1 and RVV-AE air-to-air missiles are attached to the wing hardpoints

Su-30MKIs' licensed production in India will be a staged process. Stage I envisages assembly of aircraft from assembly kits supplied from Russia, while later stages will see gradual shift to own production. India is expected to build the first 3-5 Su-30MKIs in 2004, with another six aircraft in 2005 and as many as eight fighters in 2006, reaching then the rate of 10 planes per year.

Russian companies cooperating with India in the Su-30MKI programme will help renovate HAL enterprises to be included in the aircraft license production cycle. These comprise the Nasik-based aircraft production plant, the engine-building plant in Koraput, the aircraft units production enterprise in Laknau, avionics manufacturing plants in Hyderabad and Korv. Under the contract Russian companies in early 2002 started handover of technical documentation pertaining to the airframe, the engine, and avionics, followed by technological equipment, part of which will be built in India. Local enterprises are expected to be retrofitted within several years to allow India to produce hi-tech, knowledge-intensive warplanes as Sukhoi Su-30MKI seems to be in the middle of the decade.

Thus, by 2020 the Indian Air Force will have fielded 190 Su-30MKI fighters, most of which will be able to remain in the inventory until 2030-2040 or even longer, considerably tipping the balance of forces.

India may not be the only country to field super-manoeuvrable Su-30MKI multirole fighters. It is highly likely that another state of the same region, namely Malaysia, will also operate similar aircraft in the near future. At the moment the country is considering options of expanding its fighter aviation fleet, incorporating 18 Russian-built MiG-29s and eight US F-18Ds, by fielding 18-24 multirole aircraft with a greater range. The most likely bidders to be awarded the contract of the Malaysian Royal Air Force include the Russian Su-30MKM and the US F-18F Super Hornet. The former was represented by the afore-mentioned pre-production Su-30MKI, side No 04, at the LIMA 2001 air show.

The still non-existent Su-30MKM fighter (the last M standing for Malaysian) will be based on the Su-30MKI and will have the same airframe, power plant, and fly-by-wire system, should the Malaysian contract be secured. The avionics suite will most likely be the only difference. French display and navigation systems and the Israeli ECM equipment will be replaced by similar Russian systems. At the same time, given Malaysian advances in electronic industry, the Su-30MKM is planned to be fitted with some locally produced systems. The aircraft will be produced in Irkutsk, while the regional Su-30MKI maintenance centre to be established in the neighbouring India may be used for their maintenance. The final decision on Malaysia's choice, and thus, on the very development of the Su-30MKM fighter, will in all likelihood be taken in 2003.

The Su-30MKI programme manifestly demonstrates that Sukhoi and other enterprises cooperating in development of Flanker fighters are successfully integrating into the global aerospace industry. They offer warplanes meeting the most stringent customer requirements, and are ready to fit their aircraft with the best foreign-made avionics and weapons systems. The Flanker development team is also proud to offer a mutually beneficial programme for license production of Sukhoi fighters (a key to development of the customer country's national aircraft industry), as well as a number of off-set programmes. Sukhoi's next move may be participation in international programmes of new generation aircraft development, an ambition based on the Su-30MKI programme's success.

Andrey FOMIN

In 2002 Su-30MKI entered service with No 20 Sqn of the IAF

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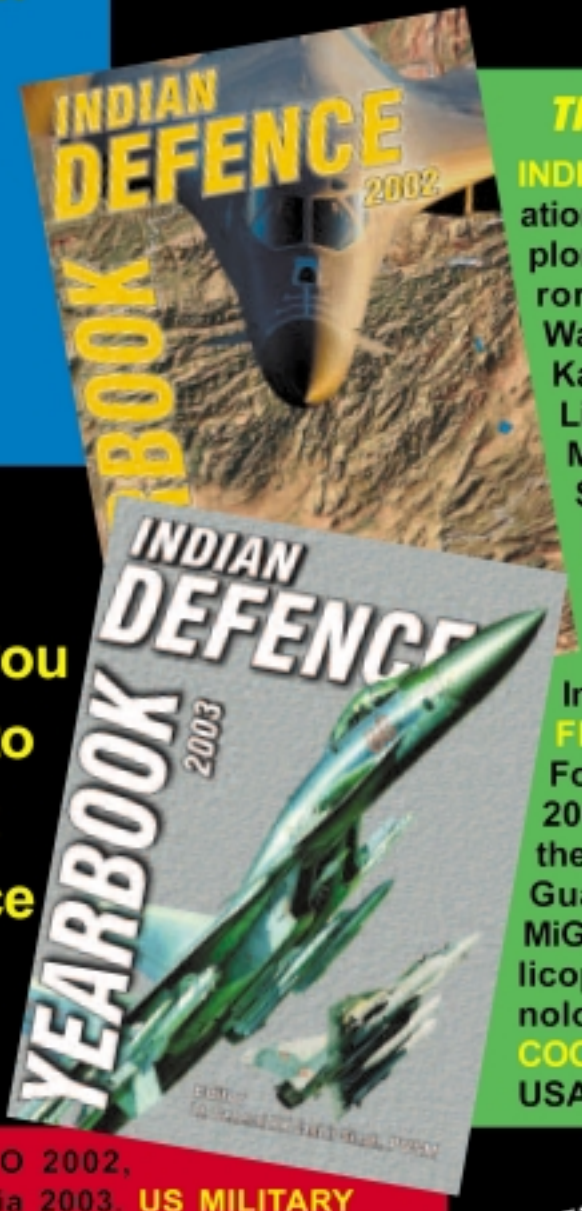

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CHOOSING THE BEST SHIP-BORNE FIGHTER

Two dozen aircraft carriers are currently operated by navies all over the world. Despite the fact that the assets used to be the exclusive part of maritime powers' inventories, now even far less affluent nations seek to secure superb capabilities of aircraft carrying ships. Naturally, these countries cannot afford heavy nuclear-powered ships carrying a hundred fixed-wing and rotary-wing aircraft, similar to those in service with the US Navy. Despite the fact, the nations in question can procure less efficient steam-turbine vessels carrying several dozen aircraft, or second-hand ships phased out from the inventories of maritime powers, their cost maximally reduced. Such ships have already been adopted by India, Brazil, Thailand and some other nations.

Service life of an aircraft carrier is much longer than that of a ship-borne aircraft. Ships built 30, 40 and even 50 years ago are still very much in service, while sea-based aircraft get obsolete after 10 or 15 years of operation, their service lives coming to an end, too. Aircraft carriers are easy to modernise through fitting them with new electronic equipment and cutting-edge air defence assets. The upgrade should also include refitting the ships for new aircraft, adequate composition of the air group being of prior importance.

As far as aircraft's employment as part of a limited air carrier group is concerned, current development of ship-based aviation testifies to versatility of conventional (i.e. non-VTOL) fighters providing air defence cover to battle groups and engaging both surface and submarine targets. Several types of such ship-borne aircraft have been developed in the USA, France and Russia recently. These are classified into two categories; the first class comprises light aircraft such as the Mikoyan MiG-29K, Boeing F/A-18 and Dassault Rafale-M, their take-off weight ranging from 15t to 25t, while the second group includes relatively heavy fighters, namely, the Sukhoi Su-33 and Su-27KUB, Northrop-Grumman F-14, their take-off weight varying from 25t to 35t. The carrier's deck and underdeck hangar provide space for a larger number of light rather than heavy aircraft, yet light fighters mount less combat load and their combat radius and weapon systems' capabilities are inferior to those of their heavy counterparts. All this makes the option for either type of the aircraft extremely difficult, unless political interests are at stake. Vitaly Orlov, Candidate of Engineering and a well-known Russian expert in combat efficiency of naval aviation, offers an insight into the problem of identifying efficient composition of air groups based on medium-class carriers.

The problem of identifying efficient dimensions of carrier ships and sea-based aircraft arises every time experts are to engineer an aircraft carrier, that is when they face the task of determining characteristics of a ship mounting aircraft with preset parameters, or that of calculating parameters of aircraft with the ship's dimensions pre-determined, or of identifying characteristics for both the aircraft and the carrier in case of size or financial restrictions.

In an easiest situation, when it is not necessary to model combat operations, the task boils down to selecting a better aircraft of the number of similar type assets on the basis of the vector criterion made up with three components.

The combat load/occupied area ratio is the principal yardstick used to assess efficiency of an aircraft, where combat load means the number of guided weapons or the weight of unguided ordnance, while occupied area stands for the area,

Table 1

Characteristics	Aircraft 1	Aircraft 2
Maximum take-off weight, kg	23,000	33,000
Maximum combat load, kg	4,500	6,500
Combat radius, km (with combat load, kg)	900 (2,500)	
(with drop fuel tank)	1,200 (6,500)	
Number of hardpoints	8	12
Number of aircraft deployed on carrier (including those on flight deck)	30 (12)	18 (6)
Take-off intensity, aircraft per minute	0.5	0.5

The concept of "large aircraft for large ships" and, thus, that of "small aircraft for small ships ", is prevailing nowadays. The theory has been proved by international practice of determining the number of aircraft on the basis of the ship's draught. The quota of displacement per one aircraft ranges between 900t and 1,300t. The lower margin of the index is for helicopter carriers or ships mounting VTOL aircraft, that is assets that can be employed without additional deck-based equipment such as catapults, ski-jump ramps and blast fences, arresting gear, etc. The aircraft of the type have light take-off weight and small dimensions.

Yet, it is not correct to determine dimensions of carrier ships and aircraft on the basis of the above-mentioned draught quota only. Combat efficiency parameters for battle group and sea-based aircraft are impossible to identify through dealing with weight and dimensions characteristics alone.

This leads one to believe that calculations of the dimensions of aircraft and carriers should be based on combat efficiency requirements, above all. Technical problems, if any, related to accommodating the aircraft on the deck of the ship will necessitate some laxity of requirements set to the aircraft and the ship.

Below is the pattern of determining efficient dimensions of aircraft to be mounted on a carrier.

occupied by the aircraft onboard the carrier. In consideration of the option for the aircraft type the parameter is to be of prior importance. According to it, preference should be given to assets with the largest combat load-to-occupied area ratio.

The area occupied by the aircraft determines efficiency of the air group through three characteristics of the carrier, that is through the capacity of the hangar deck, the number of parking lots and take-off positions, and the number of aircraft the ship is able to land in a row. Since design characteristics of specific aircraft and carriers should be taken into account, too, the combat load/occupied area ratio is to be represented as the number of aircraft based on a particular carrier.

The second component is how many aircraft can take off in a unit of time, that is the take-off intensity. Minimising the parameter will lead to greater efficiency of the flight deck employment, better use of the air group through employment of the aircraft accommodated in the hangar, increase in the group's combat radius through reducing reaction time of the aircraft complement.

The third parameter to be taken into consideration is combat radius of the aircraft. Fighters with insufficient combat radius cannot be considered to be a viable option, for if this is the case,

combat task will never be completed in the first place.

All the three criteria mentioned above can be represented as a function of the weight divided by the area and multiplied by the take-off intensity and combat radius. To some extent the function in question is a generalised equivalent of capacity divided by the unit of area ((kg x m/s) x 1/m²).

All the three components are included in the assessment of the efficiency of both the aircraft and the carrier-based air group; they are either preset or uniquely calculated for each type of the aircraft based on a specific carrier:

for aircraft:

- dimensions, including with folded wings;
- combat load weight, number of hardpoints and weapons inventory;
- combat radius with different weapons suits;

for carriers:

- number of aircraft of the specific type that can be based on the carrier;
- take-off intensity;
- number of aircraft in the first and subsequent take-offs;
- number of aircraft landing.

Hence, combat capabilities can be determined for each type of the aircraft deployed on a specific carrier.

For instance, the carrier under consideration has the following dimensions: flight deck length is 280m, width 60m, hangar deck area 2,600 sq. m. The take-off/landing scheme includes a ski-jump ramp, two take-off positions and arresting gear. The two alternatives, Aircraft 1 and Aircraft 2, with different dimensions have the following characteristics (Table 1).

Comparison on the basis of the aforementioned criterion shows that Aircraft 2 is twice better (if max combat load is considered) and has 1.8 advantage (if number of hardpoints takes into account).

Yet, as was mentioned above, the problem, the way it has been put for consideration, is of no great difficulty, being, in essence, an initial assessment.

The results of the analysis should be used to select the best option, that is the aircraft capable of delivering the required combat load furthest, when deployed on the carrier.

Despite the fact that these characteristics determine the overall efficiency of the aircraft and air group, analysis of combat parameters cannot be based on them alone, since to efficiently employ ordnance is as important as to deliver it to the greatest distance possible. Thus, a more accurate study of combat potential of carrier-based aircraft provides for comprehensive analysis of their weapons control systems, composition of combat load and capabilities of the weapon suit, which makes modelling of combat operations indispensable.

Table 2

	Aircraft 1	Aircraft 2	Aircraft 3
Air-to-air weapons:			
long-range	2	8	8
medium-range	4-6	10	10
short-range missiles	2-8	2-4	2-4
air-to-ship missiles	4	6	6
air-to-surface missiles	2-4	2-6	2-6
guided bombs	6	6	6
unguided weapons	4,500	6,500	6,500
max load, kg	(2,500)*		
Fire control system:			
Radar			
detection range, km	100	100	150
number of simultaneously engaged airborne targets	2	2	4
Optronic sighting system	available	available	available

Suppose there are three alternatives designated as Aircraft 1, Aircraft 2 and Aircraft 3. Characteristics of the assets' avionics and armament are specified in Table 2. Aircraft 2 and Aircraft 3 have identical dimensions, yet the latter boasts a more sophisticated weapons control system.

Parameters of combat efficiency of an air group made up with Aircraft 2 and Aircraft 3 as compared to those of the air group comprising Aircraft 1 are specified in Table 3.

The data in Table 3 enables one to draw some conclusions as to preference for one of the three alternatives:

1. The principal mission of the assets, including engagement of airborne targets, consists in providing anti-aircraft cover to friendly battle groups. Since efficiency of air defence is dependent on the number of aircraft engaged in the mission (aircraft in deck hangars are unable to take off with the first group), aircraft number ratio should be determined on the basis of the number of aircraft taking off from the flight deck and those on patrol, if any.

Table 3

Aircraft 2 (3)-to-Aircraft 1 ratio	Combat Mission					
	Engagement of airborne targets		Engagement of surface targets		Engagement of ground targets	
	Aircraft 2	Aircraft 3	Aircraft 2	Aircraft 3	Aircraft 2	Aircraft 3
1:1	1.3-1.4	1.6-1.8	1.5	1.5	2.6-2.9	2.7-3.0
1:1.5	0.9-1.0	1.1-1.2	1.0	1.0	1.9-2.1	2.0-2.1
1:2	0.65-0.7	0.85-1.0	0.75	0.75	1.3-1.4	1.3-1.5

The maximum number of Aircraft 1 and Aircraft 2 (3) deployed on mission in the first take-off is 12 and 6 aircraft respectively; that with two fighters already on patrol is 14 and eight, respectively, which sets the ratio at 1:2 and 1:1.75.

With the ratio of 1:2, Aircraft 2 cannot be considered a viable alternative, while Aircraft 1 and Aircraft 3 have similar combat capabilities.

In case the ratio is 1:1.75, Aircraft 3's superiority over other alternatives becomes more salient.

2. Missions of engaging surface targets are, too, to be assigned to the group based on the flight deck and capable of staging a mass raid. Thus, the Aircraft 2 (3)-to-Aircraft 1 ratio is 1:2, which makes Aircraft 1 a better choice.

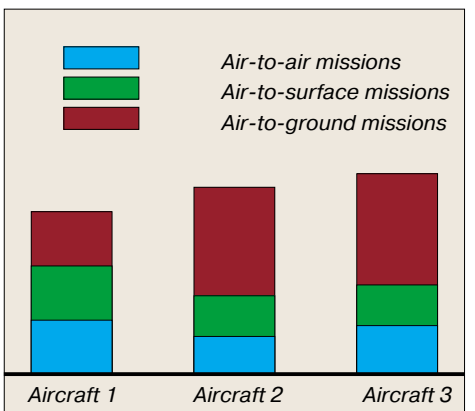
3. Launching strikes on ground-based targets is to be carried out as part of a multi-step operation, that is why all assets of the air group are to participate in the mission.

In accordance with the Aircraft 2 (3)-to-Aircraft 1 ratio of 1:1.67 (Table 1), Aircraft 2 is superior to Aircraft 1, while Aircraft 3 is a better option when opposed to Aircraft 2.

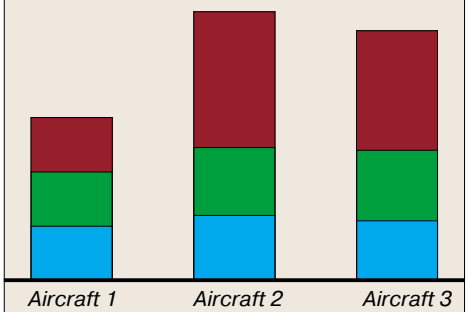
Aircraft cost ratio rather than number ratio is to be used in case the cost of ship-based aviation assets is determined by the cost of aircraft deployed on the carrier. Decision on the choice of the aircraft should be made on the basis of cost ratio. For instance, if the cost ratio is 1.2:1 for Aircraft 2 and Aircraft 1, 1.4:1 for Aircraft 3 and Aircraft 1, the left column of Table 3 will read ratios of 1:0.83; 1:1.25; 1:1.67 for Aircraft 2 and Aircraft 1, and 1:0.71; 1:1.07; 1:1.43 for Aircraft 3 and Aircraft 1.

This means that, the cost/efficiency criterion being of prior importance, Aircraft 2 and Aircraft 3 are more preferable, which is not the case when combat efficiency alone is used as the principal yardstick, since Aircraft 1-to-2-to-3 effectiveness grows faster than their respective cost.

Vitaly ORLOV



Combat effectiveness comparative characteristics of carrier-borne air group consisted of aircraft 1,2 and 3



Combat effectiveness comparative characteristics of carrier-borne air group consisted of aircraft 1,2 and 3 considering their cost (cost/effectiveness criterion)

KAZAN

VIP TRANSPORT HELICOPTERS

The Russian Mi-17 multipurpose medium lift helicopter is globally recognised as one of the most reliable and safe rotorcraft. These helicopters have been manufactured for several decades, but they are still not outdated thanks to constant structural modernisation and introduction of advanced rotorcraft technologies. Unique flying performance, cutting-edge avionics, and special Russian- and foreign-made equipment enable the helicopter to fly at high altitudes, in adverse weather, day and night.

The high level of safety, reliability, ease and low cost of operation and maintance have made the Mi-17 the globally best-selling helicopter in its class. Mi-17s are operated all over the world; there is hardly a region where these undemanding and amazingly survivable machines would not be known. The Mi-17 and its predecessor Mi-8 are in service with armed forces of over 80 countries, and about 200 carriers operate them worldwide.

The Mi-8 and Mi-17 were developed in over 150 modifications, VIP variants being the most interesting of them. The Mi-8 was perhaps the world's only helicopter to be designed with the view for further development into a top-rate government VIP transport (this was the essential condition for the program's support from Russia's leader Nikita Khrushchev). The Mil Design Bureau did its best to develop the baseline Mi-8 into a dozen VIP versions.

Kazan Helicopters Joint Stock Company is the major Mi-17 manufacturer. The enterprise has by now built over 7,500 Mi-8 and Mi-17 helicopters in various modifications. Kazan specialists avail of their decades-long expertise in designing VIP transport helicopters. The enterprise developed the first VIP helicopters in the 1960s from the famed Mi-4 model; later VIP helicopters were based on the Mi-8 and its further modernisations.

Kazan-built VIP transport helicopters were exported to dozens of countries. The majority of these machines were tailor-made for the most privileged customers. Leonid Brezhnev and other top-ranking state officials of the Soviet Union and other states used Mi-8 VIP modifications as their personal and service transports. Nowadays, VIP helicopters manufactured in Kazan are used by government members of many East European, Asian, African, and Latin American countries.

Today Kazan Helicopters develops a variety of VIP options based on the Mi-172 multipurpose civilian helicopter, which holds type certificates issued by Russia, India, and a number of other countries. The Mi-172 VIP transport variant provides highest-level functional efficiency, safety, and comfort. The enterprise consistently refines cabin layout, interior, and equipment to meet increasing customer demands and ensure the highest level of comfort.

The spacious Mi-172 cargo/passenger cabin offers innumerable layout and equipment options to satisfy the most demanding customer. The cabin space may be compartmentalised into the main cabin, quarters for bodyguards, flight attendants and accompanying passengers, office/special communications centre, entrance hall, cloakroom, galley, public convenience room, and cargo/baggage compartment. The side airstairs/door facilitates passenger embarkation/disembarkation. The aft entrance door is reserved for maintenance personnel.

Depending on the cabin layout selected, the Mi-172 VIP transport helicopter comfortably accommodates seven to 11 passengers, although greater capacity options are also possible. The VIP cabin comes with two to four wide leather armchairs for VIP passengers and soft single or double seats/sofas for accompanying passengers. If customer so desires, luxurious US-made armchairs upholstered with most exquisite natural leather may be installed for VIP passengers. Tables (plastic or mahogany, depending on customer's choice) are made collapsible to free more cabin room when passengers need it. The armchairs and seats, fitted with safety belts, are akin in comfort to those used in luxury cars. Customers are encouraged to choose from a vari-

Leaders of many countries take priviledge of flying VIP helicopters from Kazan

Interior layout variants of the Mi-172 helicopter

ety of armchair designs and upholstery types available. Lockers with drawers may be additionally installed in cabin.

The high level of cabin comfort is ensured by efficient vibration dampening, heat and noise insulation, mild lighting, adjustable heating, air conditioning, and other climate control devices. All systems operate equally efficiently in flight and during long parking. The cabin interior is similar to those found in top-class hotels. Types and colours of trimming materials will be matched to meet customer's desires. Cabin windows are fitted with curtains or dropdown screens.

Flat LCD monitors may be installed along cabin walls and on bulkheads; additional equipment may include radio receiver, VCR, and CD/DVD player. VIP passengers can use intercom line to communicate with the crew and satellite phone to keep in contact with the entire world, without as much as rising from their armchairs. The INMARSAT global satellite system enables passengers to send fax and e-mail messages while airborne. Mi-172 VIP transport versions meant for top-ranking political and military officials are additionally equipped with special communications equipment. All communications systems operate equally efficiently in the air and on the ground.

The galley is fitted with the refrigerator, microwave oven, boiler, coffee maker, cupboard, and bar. The public convenience room is equipped with mirror, wash-stand, and self-contained toilet.

The cabin layout and design are so arranged as to provide maximum safety in case of rough landing. Armchairs and seats incorporate shock-absorbing technologies. Window frames are easily removable to accelerate emergency evacuation. Customer may additionally order up to four emergency exits. Self-sealing fuel tanks are filled with polyurethane foam to prevent fuel inflammation.

Emergency buoyancy system may be installed to guarantee at least 30 minutes of floating after splashdown – enough time for passengers and the crew to evacuate on special rafts.

To enhance flight safety at low altitudes, the helicopter may be equipped with a wire strike protection system. Upon customer's request, the helicopter may be fitted with external and built-in armour, passive countermeasures systems, etc.

The helicopter's range may be increased to over 1,000km at the expense of two additional external fuel tanks each holding 915 litres of fuel. Just like the main fuel tanks the may be filled with polyurethane foam to eliminate fuel inflammation.

The latest novelty of Kazan Helicopters are VIP transport helicopters specially designed for high-altitude regions. These helicopters are powered by high-altitude VK-2500 engines developed by the Klimov Plant, and by the Czech-made Safir auxiliary power unit (APU). As compared to the standard AI-9V APU, which ensures main engine start-up at altitudes of up to 4,000m, the Safir APU guarantees engine start-up at altitudes of up to 6,000m. The Safir also provides for much longer onboard equipment operation with main engines shut off than the Honda APU that is used jointly with the AI-9V. New engines by Klimov Plant increase the helicopter's hovering and service ceilings, and the VK-2500's emergency power of 2,700hp enables the helicopter to continue takeoff with one failed engine.

According to owners of Kazan-built Mi-172s, when flying these VIP transport helicopters "you completely forget that you are on board a rotorcraft", and "the comfort and cabin space are so great that the VIP passenger and his assistants can work as if from their ground-based office."

Vadim MIKHEYEV
Photos by Valery Solomakhin

On the wall: LCD TV, stereo system, CD player, VCR

Security communications post

Galley

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PRECISION WEAPONS DEVELOPMENT: GLOBAL TENDENCIES

The global politico-military situation has undergone major changes since the completion of world-scale confrontation between two superpowers. Nevertheless, military threats remain in many regions owing to aggravation of terrorist and extremist tendencies; the US has obviously chosen the way of building up its influence in certain regions, including through military methods. Washington has gained certain success in demonstrating its new "stand-off warfare" doctrine based on large-scale reconnaissance operations and wide use of precision weapons.

These tendencies have given birth to new concepts of weaponry development. We may highlight the following major aspects of such concepts:

- increasing importance of precision weapons over other weaponry systems;

- priority of medium- and short-range weapons over strategic offensive systems;

- increasing role of economic considerations, which prompt nations to care more about upgrading their ageing arsenals;

- spreading perception of precision weapons not only in terms of their accuracy but also in terms of precise calculations of such weapons' lethality to minimise collateral damage.

Economic considerations are critical both to countries with limited economic potential and industrialised nations, with stand-off warfare being extremely costly. For example, some US experts believe the probable anti-Iraqi campaign may cost Washington tens of millions of dollars (up to $200 billion).

Understanding the increasing role of shorter-range precision weapons, the US works to improve these types of weapons systems.

The AGM-65 Maverick tactical air-to-surface missile, first used during the Vietnam War, is a globally ubiquitous precision weapon. Up to 5,000 AGM-65s were launched during Operation Desert Storm. The missile's small weight and dimensions enable operation from virtually all types of airborne platforms against a wide range of targets; the modular design has facilitated repetitive modernisation of the missile. The AGM-65 can be used against the most common target types: fortified installations, bunkers, hangars, parked aircraft, armour, air defence systems, port facilities, vessels, etc. Depending on configuration, the launch weight of contemporary Maverick versions may reach 307kg. The two warhead types of the AGM-65 are a 57kg cone-shaped charge and a 136kg delayed-fuse penetrator. The missile's guidance system utilises electro-optical television sensors, laser and heat seekers, and – in later modifications – a thermal imaging system. The latest modernisation variants incorporate state-of-the-art television imaging technologies, hardware, and software offering more accurate target identification, etc.

Another example of globally-spread tactical precision weaponry is the AGM-84E SLAM missile developed by Boeing from a family of Harpoon anti-ship missiles. Although the first variant of this missile entered service in 1976, consecutive upgrades help it remain one of the most widespread tactical precision weapons. The latest Harpoon Block II upgrade programme is aimed at enabling the missile to attack coastal, littoral, and blue water ship targets.

The Block II programme is centred on enhancing the missile's precision guidance capabilities in hostile ECM environments. The Global Positioning System/Inertial Navigation System (GPS/INS) in combination with a precision radar altimeter guide the missile through the cruising flight stage. In the terminal phase of attack the operator aims the missile onto the target's infrared image displayed on his monitor, after which the missile's homing mode is activated. With a weight of 620kg, the AGM-84E can deliver a 220kg warhead to a range of up to 100km. The AGM-84H SLAM-ER variant, under development since the mid-1990s, may eventually incorporate a five-channel GPS receiver, a laser gyroscope, and adaptive terrain following equipment. A freeze-frame-capable video camera simplifies the aiming process. Future Harpoon variants may incorporate equipment for automatic target identifying equipment to match the seeker images with reference target images from satellite databases or other sources; they may also be fitted with real-time target designation equipment feeding data to the control centre.

The major US rival of newest SLAM-ER modifications is the AGM-158 JASSM (Joint Air-to-Surface Standoff Missile) developed by Lockheed Martin, with production launched in 2001. The 930kg missile can carry a 320kg warhead to a range of up to 115km. The mission planning phase for the JASSM is reduced from six hours to one hour through introduction of the autonomous target identification mode utilising target images generated by a E-8 Crusader-based radar or by satellite systems.

Contemporary Western-designed precision weapons projects are typically universal platform-nonspecific (airborne/sea-deployed/land-based) tactical missiles capable of destroying a wide range of targets. In this connection developers are looking into the possibility of using a millimetre wave active radar seeker to provide appropriately high resolution and required signal/noise ratio for efficient attacks on small-size targets in cluttered spaces.

We should note that in the short run (through to 2007) the US perceives development of tactical supersonic (or hypersonic) guided missiles merely as an alternative variant, still believing that subsonic low-altitude missiles incorporating elements of stealth technology may be very efficient.

France retains a leading position among Western nations in developing supersonic guided missiles. In 1998 Paris commenced research to draw up the concept of the future ANF (Anti-Navire Futur) anti-ship missile to replace the well-known Exocet AM.39. The ANF is required to have a range exceeding 150km and a cruising speed of M=2.5-3.0. The ANF system is the first Western supersonic tactical guided missile project. Russia, by contrast, already produces supersonic tactical weapons like the 3M80E Moskit anti-ship missile, the Yakhont anti-ship missile, and missiles of the Kh-31 type.

The high-speed Kh-31A anti-ship missile and the Kh-31P anti-radiation missile developed by the Zvezda-Strela State Science and Production Centre are the world's only production small-size supersonic missiles (in the weight category of up to 600kg). The Kh-31A's high speed decreases vulnerability to enemy sea-borne air defences, and the Kh-31P is successful in duels with missiles of the most advanced anti-air systems.

It may be appropriate to note that Zvezda-Strela bases its production programme on contemporary global trends in armament development to create truly advanced precision weapons. The enterprise traditionally concentrates its R&D efforts on development of short- and medium-range precision-guided missile systems. Modern modular modifications of the Kh-25M missile family are in no way inferior to the latest variants of the US AGM-65 missile. Zvezda-Strela offers a programme to retrofit previously delivered Kh-25M missiles to variants fitted with semiactive laser (Kh-25ML), TV homing (Kh-25MT), and imaging infrared (Kh-25MTP) guidance systems, and also to the new Kh-25MPU anti-radiation version with combat potential enhanced through extension of the radar seeker's frequency band and introduction of an inertial navigation system offering flight trajectory prolongation and repeated lock-on after temporary deactivation of the target's radar.

Another development offered by Zvezda-Strela is the platform-nonspecific Kh-35E anti-ship missile, a real competition to missiles of the AGM-84 type. The Kh-35E may be used with the Uran-E ship-borne missile system, mounted on front-line aircraft and patrol airplanes, or operated as part of rotorcraft-borne missile systems. Kh-35Es may also be used with the Bal-E mobile coastal defence missile systems.

The Kh-35E's low-altitude flight path, small dimensions, and emission-secure radar guidance system enable the missile to efficiently engage sea targets in hostile ECM environments. The missile proceeds to target at a high transonic speed, flying at 10m to 15m above sea surface in midcourse phase and at about 4m in the terminal phase. The high load ratio of the 520kg aircraft-borne variant enables the missile to deliver a 150kg warhead to a range of up to 130km.

In hostile ECM environments the missile is guided by an advanced integrated onboard system comprising the active radar seeker, inertial navigation system, and precision radar altimeter. A complex coherent signal used in the active radar seeker provides for accurate target selection by target speed and ensures efficient ECCM capability through implementation of special structural and algorithmic solutions.

The Zvezda-Strela State Science and Production Centre is currently under reorganisation into the Tactical Missiles Corporation JSC, to form a large trans-industry company that would operate in the interests of the Russian Defence Ministry and promote marketable produce to the global arms market.

Successful competition in the international market calls for consistent research of global trends in weaponry development. Analysis of current and future trends demonstrates that the world's leading arms manufacturers are concentrating their efforts on the following major research tasks:

- implementation of data channels operating in a wide range of data transmission/reception frequencies, from optical band to radio band;
- development of multiple channel guidance systems with integrated processing of data fed through different channels;
- enhancement of missile guidance and target identification through wider use of information about the target's physical fields; real-time targeting with use of long-term and ad-hoc generated target profiles;
- development of integrated onboard guidance and data processing systems based on open architecture principles;
- fitting warheads with controlled fuses for arbitrary detonation.

Zvezda-Strela engineers closely interact with Russia's leading research centres in developing state-of-the-art weapons. The forming of the Tactical Missiles Corporation JSC will open wider horizons for modernisation of precision guidance weapons and development of globally competitive platform-nonspecific multirole missiles.

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AEROFLOT:

INTO A NEW YEAR WITH A NEW IMAGE

Having retained operational stability for 80 years of claimed history, Russia's flagship carrier Aeroflot is keen to renew its fleet of foreign-made aircraft, implement programs to enhance efficiency, and overhaul its image. Passengers subconsciously appraise the level of service based on the outward impression of the carrier. Fine dress helps to impress, so Aeroflot's decision to design new flight staff uniforms appears a logical step towards a new image.

First impressions are most lasting, and this is doubly so for the way flight attendants are dressed. The world's leading carriers regularly redesign personnel apparels, and Aeroflot has always been up to the mark – people the world over traditionally feast their eyes upon elegant uniforms of Russian flight attendants.

The currently adopted Aeroflot crew and flight attendant uniform type was designed by famous Russian couturier Valentin Yudashkin six years ago – too long a period in the fast-changing world of fashion. Outdated and excessively militarised, this service wear has to go. New fabrics developed over the past few years opened new design opportunities for creation of functional, elegant businesslike uniform types to be worn in different climates, different seasons, and under electrostatics conditions (who would like being electrocuted by a foxy stewardess?).

Aeroflot has announced a tender for the best uniform design. Eight Russian couturiers ran in the first round of the tender. No foreign designers volunteered to run, but that is just as well – it will be easier for domestic modelers to reckon with the national flavor, for each airline needs its own, strictly individual fashion.

The contestants were requested to exploit the blue-and-orange color scheme corresponding to the carrier's perception of sunrise over clouds. Most of Aeroflot employees polled prior to the tender voted for this colorific combination. The poll also revealed that female personnel would much love to get a wide range of accessories (scarves, kerchiefs, etc.) and see the would-be uniforms made of easy-to-clean "shape-memory" fabric.

The terms of the tender imply that each modeler presents four uniform sets: for crewmembers, flight attendants, ground passenger servicing personnel, and Aeroflot ticket office staff.

The demonstration of the tender's results will be set in a near-real environment, with actual flight attendants posing as models in situations approximated to natural flight environments. This will allow the audience to best appraise the nominees' designs from the standpoint of visual effect and utility.

The tender jury will consist of Aeroflot top managers and visiting fashion experts.

The first demonstration round will be held during the 9 February 2003 celebration of Aeroflot's 80th anniversary. The project will be accomplished sometime in the first half of 2003, and all Aeroflot passengers will be able to appraise the carrier's new style.

The image renewal will not be confined to uniforms. With Aeroflot's fleet renovation program underway, new cabin interiors will certainly call for reconsidered onboard services. Aeroflot management intends to try out a new service concept, sloganed "Russian hospitality hosted by sincere, cordial people: a blend of the best traditions and modernity". The concept stipulates a new approach to servicing technologies, new flight attendant training methods, and modification of the carrier's brand style.

These radical changes will take place in the year of the 80th anniversary of Aeroflot, one of the most famous brands in Russia and one of the most famous Russian brands in the world.

Under the brand revision program, 152 Aeroflot flight attendants took a training course in new servicing techniques and image concept implementation and were instructed in handling new meal courses to be introduced.

Along with modernisation of the passenger servicing technology, the quality of food catering has also improved: passengers will now be offered more varied menus, including a selection

of courses from European and Russian cuisines, hot soup, a wide range of hors d'oeuvres and desserts, and ice cream.

The carrier will implement a stepwise program to renovate onboard nourishing services. In late 2002 the new servicing model was introduced on the Moscow-New York-Moscow route. Twenty-four cooks were trained at best restaurants in Moscow and abroad to produce Aeroflot's new menu. The selection of courses and drinks has already been coordinated and approved, and new functional 16-item crockery/cutlery sets await their first users.

After the project has been tested on Aeroflot's Moscow-New York-Moscow operation, in March 2003 the new technology is expected to open on the carrier's Paris and Tokyo services.

It's hardly worth reminding that any company's greatest value is its employees. There are no fillout boxes for things like good cheer on your company payroll, but if you don't take a formal stand on the issue you can make your staff's day on an appropriate occasion. Thus, in preparations for its 80th jubilee Aeroflot held a song contest dedicated to this festive event.

Aviation makes people romantic, and romance is known to inspire creative souls. Flying, signing, and loving seem to be so very intertwined that they coexist not only in professional lyrical works but also in songs by rank-and-file aviators. Deputy Aeroflot Director General Lev Koshlyakov said in his address to the song contest participants that the 80th anniversary of Russia's civil aviation was by right the aniversary of Aeroflot, since those two notions had long become synonyms in Russia. This is perhaps why many nominees sang about Khodynka, one of the first Russian airfields located not far from the Aeroflot headquarters. Lyrics tracked the carrier's history back to the times when the national colors on the fins of Aeroflot airliners denoted the Soviet Union's presence in many regions, epitomising its political significance and industrial might. No other operator has up to now managed to beat Aeroflot's 1990 record, when its airliners carried 130 million passengers.

The contemporary history of Aeroflot is a well-calculated combination of business, commerce, and computer-aided route networking. But this does not mean the romance of flight is lost to the pace of time. In the end, it is the romance that prompts highly qualified specialists join Aeroflot to fly its airplanes high and safe.

Nikolai VALUEV,
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AN-140

"PEOPLE'S TRANSPORT" FROM KHARKOV

The history of this aircraft began a couple of years after the USSR breakup, amid a severe economic crisis. Already at that point it was clear that CIS civil aviation would soon find itself without a contemporary regional airliner: the An-24 turboprop, which used to account for around 30% of civil transportation in the Soviet Union, had by then exhausted all options for service life extension, fuel effectiveness enhancement, and upgradeability.

Therefore, the Antonov Design Bureau specialists initiated development of a new aircraft designated An-140. Antonov Designer General Pyotr Balabuyev first officially announced the An-140 programme at the 40th Paris Air Show Le Bourget in June 1993.

The programme got a national status in February 1994. Designers were tasked with making the future aircraft pilot-friendly, maximally efficient, comfortable for both passengers and the crew, easy to maintain, and cheap to manufacture. Mr. Balabuyev referred to the An-140 project as "a people's aircraft", implying that the new airplane was to stop passenger outflow from Ukrainian and Russian civil aviation.

The decision was made during the preliminary design stage to develop an airplane that would comply both with the NLGS-3 CIS airworthiness requirements and with the FAR-25 airworthiness standards for transport category airplanes. Further introduction of the AP-25 regulations enabled the project team to run a full development cycle under these new standards' requirements and procedures. This approach helped reduce technical risks and in the long term saved the project team much time on ground and flight testing.

As was established during the design phase, the An-140 would surpass the An-24 in performance if powered by engines with not less than 2,500hp power each. The ZMKB Ivchenko Progress Design Bureau completely reconfigured its production TV3-117VMA turboshaft helicopter engine, making it twin-staged to minimize air intake losses and obtain the required propeller shaft power. Dubbed TV3-117VMA-SBM1, the modified engine has an emergency power of 2,800hp.

In the very initial phase, the An-140 programme was joined by the Kharkov State Aircraft Manufacturing Company (KSAMC), one of the two facilities entrusted with production of new regional airliners (the other facility being the Samara-based Aviacor Aircraft Plant). Being one of the CIS oldest aircraft production enterprises with a 75-year history of operation, KSAMC had earned wide recognition for production of reliable Tupolev passenger aircraft that were launched in the mid-1950s: first it was the Tu-104, then the Tu-124, and finally, the Tu-134. Several hundreds of KSAMC-built Tu-134s are still operated by carriers the world over.

After the 1984 phase-out of the Tu-134 programme, with 852 these type of aircraft to its record, KSAMC launched production of Antonov's new transport jets, the An-72 and An-74. The first An-72 was rolled out in 1985; production of the modified An-74 was launched in 1989. KSAMC has by now built over 150 such aircraft in a number of variants, with 75 An-74s delivered to customers during the most economically difficult period between 1991 and 1999. Analysts believe that the KSAMC-produced An-74 has come to be virtually the best-selling civil aircraft across the CIS since the USSR's disintegration.

Kharkov aircraft engineers took an active part in development of several new An-74 modifications. They developed and launched production of the modernized An-74T-100 and An-74T-200 transports, the An-74TK-100 and An-74TK-200 cargo/passenger convertibles, the An-74-200D VIP aircraft, etc. Their latest achievement is the An-74TK-300 modernization, which was awarded an airworthiness certificate in September 2002.

In the mid-1990s KSAMC built several An-140 prototypes, and later on the enterprise launched An-140 production.

The Antonov Design Bureau rolled out the first An-140 prototype on 6 June 1997; the aircraft made its first flight on 17 September 1997.

The intensive testing programme included flight tests, which went on until February 1999 and helped eliminate a number of design defects. The An-140 was then officially submitted to the Aviaregistr certification body of the CIS Interstate Aviation Committee and to the Ukraviatsia Ukrainian State Aviation Administration for joint certification tests. Overall, by the 26 March 2000 completion of the certification programme three An-140 test aircraft had performed 1,138 flights logging a total of 1,286 flight hours.

The An-140 was tested in a variety of critical conditions: in icing conditions in northern Russia; at slippery and snow-clad airfields; at up to +45°C in Uzbekistan; at high-altitude airfields of Kyrgyzstan; and at down to -55°C in Yakutia. Test pilots simulated engine, system, and equipment failures during takeoff, enroute flight, and landing. As a result, the An-140 was recommended for unrestricted operation.

On 25 April 2000 the An-140 was awarded a type certificate. The first production aircraft was built by KSAMC in August 1999; on 11 October 1999 it performed its maiden flight.

In the meantime, Iranian aircraft engineers at HESA's Isfahan facility were developing a trilateral

An-140 programme. The high authority of the Antonov Design Bureau and KSAMC had prompted Iran already in the design phase to select the An-140 as a future airliner for its domestic carriers; in 1995 the aircraft won Iran's tender over rivals by ATR, Bombardier, and SAAB.

Tehran's urgent need of a relatively cheap multipurpose aircraft made it request corresponding technical documentation from Antonov and KSAMC ever prior to the flight testing programme's completion. The first HESA-built production aircraft, dubbed IrAn-140, made its first flight on 4 February 2001.

The Samara-based Aviacor Aircraft Plant, another An-140 manufacturer, had built several aircraft by late 2002. The An-140 programme unites nearly 300 Ukrainian, Russian, and West European companies, such as ZMKB Ivchenko Progress (development of engines and auxiliary power units), Motor Sich (engine production); Kharkov-based InterAMI Corporation (passenger cabin interiors); Stupino, Moscow Region-based Aerosila company (AV-140 propellers), etc.

The first An-140s entered service in July 2002, when the newly-founded Aeromist-Kharkov carrier leased two such aircraft from KSAMC under a 15-year instalment plan for domestic and international operations. Shortly afterwards the carrier opened its first An-140 Kharkov-Kiev-Kharkov service. Aeromist An-140s currently operate seven scheduled weekly flights from Kharkov's Zhulyany Airport to Kiev, two weekly flights to Uzhgorod, and one weekly flight to Batumi. The carrier's An-140s transported over 10,000 passengers over the period from March to December 2002, with the flagship aircraft's average monthly operational time amounting to 180 flight hours.

Aeromist intends to shortly launch several international services, including the Bratislava operation; the carrier's other plans include resumption of traditional operations across the CIS.

To avoid An-140-related operation and maintenance problems, Aeromist has joined Corporation Avia-Alliance founded by the Kharkov Regional Administration, the executive committee of the Kharkov City Council, KSAMC, and private investors (the Russian Aeromost Airline Group and Ukraine's InterAMI Corporation).

Antonov An-140s in the KSAMC assembly hall

Aeromist-Kharkov, Ukraine's Odessa Airlines, and Russia's Eurasia Airlines have confirmed their intention to jointly operate the An-140. Eurasia Airlines will shortly join its Ukrainian partners in preparations of requisite technical documentation to speed up the An-140's service entry on Russia's domestic routes.

Second production An-140 became the first aircraft of the type handed over to Aeromist-Kharkov carrier in 2002

A Ukraino-Russian sales company established to market KSAMC-built An-140s will get registered in Moscow as a closed joint stock company. Initially incorporating KSAMC and Aviacor Aircraft Plant, the company may later on be joined by the Antonov Design Bureau, Motor Sich, and ZMKB Ivchenko Progress.

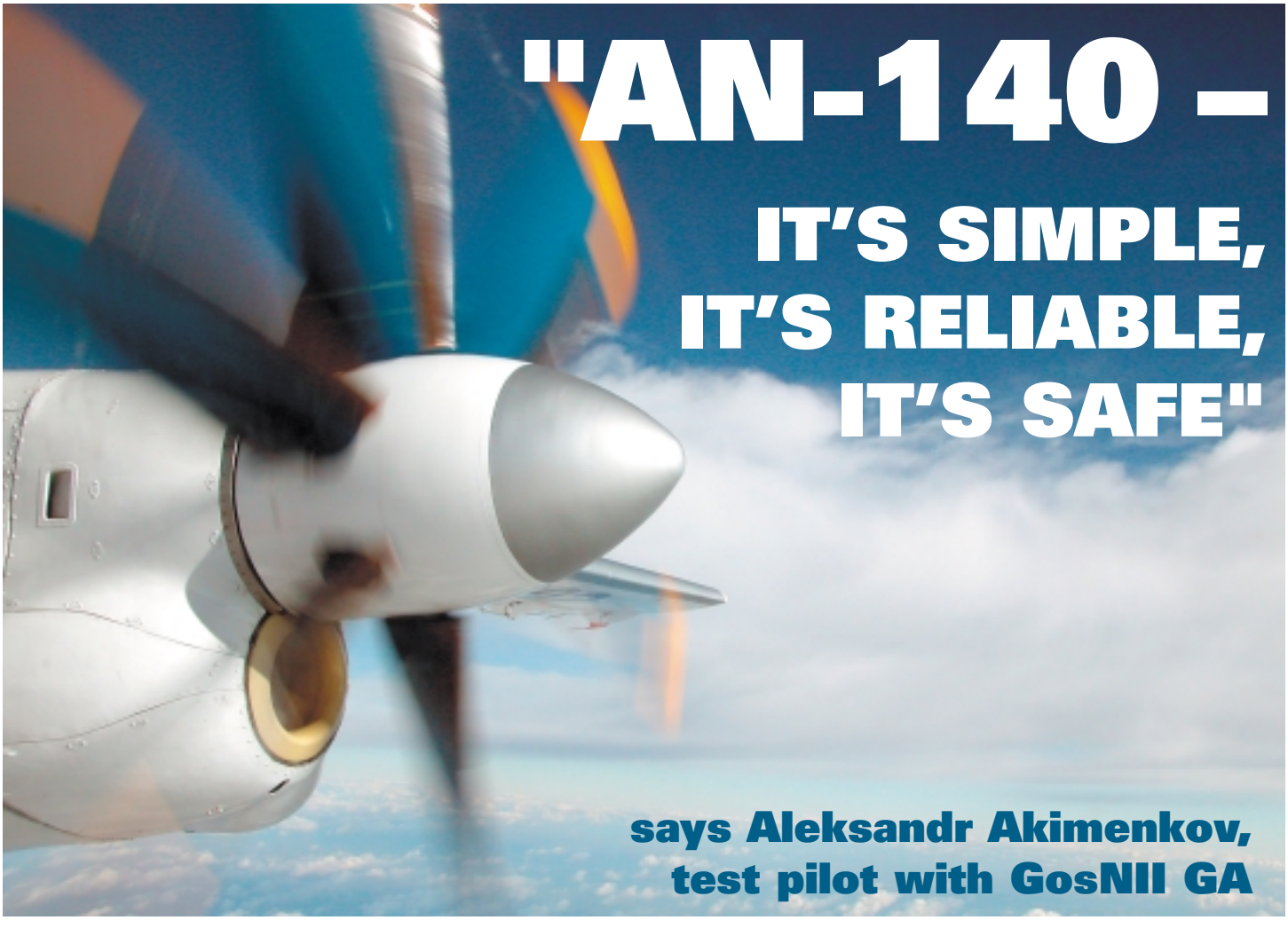
Specialists estimate Ukrainian carriers' demand for the An-140 at around 15 aircraft for the next three years, whereas Russian operators might need 80 to 100 An-140s. An agreement with Iran stipulates production of 105 An-140s at HESA's Isfahan facility.

According to Aleksandr Yurakov, chair of the Ukrtransleasing company's managing board, two more An-140s will shortly be purchased from KSAMC and delivered to Ukrainian operators, possibly to one Dnepropetrovsk-based company and one Donetsk-based carrier. Kazakhstan, China, and India operators have also expressed desire to purchase An-140s. In late October-early November 2002, a new An-140 covered over 20,000km in the record-breaking 54 hours during a long-range Kharkov-Island Kish-Zhuhai-Ras Al Khaiman-Kharkov flight. The An-140 attended Iran Airshow 2002 on Island Kish and Airshow China 2002 in Zhuhai, where it was highly praised by specialists and obtained good chances for further promotion to Asia's aircraft markets.

To our deepest regret, the An-140's prominent career was darkened by the December 2002 tragedy. At 18:59 Moscow time on 23 December 2002, the An-140 Tail No. UR 14003 hit a mountain on approach to Isfahan Airport, Iran. All those on board – 38 passengers and six crewmembers – perished. The flight was carrying KSAMC top managers, prominent Zaporozhye engineers, officials of several Russian companies participating in the An-140 programme, and press reporters. The representative delegation was on its way to the rollout ceremony of a second production IrAn-140 aircraft built under the Irano-Ukrainian programme. The tragedy claimed the lives of excellent specialists and wonderful people. They will remain in our hearts forever.

Although the investigation is still underway, preliminary reports say the tragedy did not result from any aircraft-related malfunction. Anatoly Myalitsa, Ukraine's Minister of Industrial Policy and former KSAMC director, expressed hope that the joint An-140 programme with Iran's HESA aircraft production corporation would be continued. The Iranian transportation minister likewise spoke in favour of continuing cooperation. No catastrophe can stop technical progress, which was best illustrated by the successful 26 December 2002 first flight of the second production IrAn-140.

Valery AGEYEV



"AN-140 – IT'S SIMPLE, IT'S RELIABLE, IT'S SAFE"

says Aleksandr Akimenkov, test pilot with GosNII GA

Aleksandr Akimenkov is a leading test pilot with the State Research Institute of Civil Aviation, Russia's major authority for testing all new domestic passenger aircraft. He is also an auditing expert for Aviaregistr, the CIS aircraft certification body attached to the Intergovernmental Aviation Committee. Mr. Akimenkov took the An-140 transport aircraft through a major parts of test flights under the AP-25 certification programme. The following are his impressions of the aircraft.

PREFLIGHT PROCEDURES

Any flight is preceded by ground preparations. The An-140 can easily be serviced by a crew of two. In fact, the crew can maintain the aircraft outside the base airport for as long as one month.

The An-140 crew consists of two pilots and a flight attendant, whose functions may include cargo operations and ground maintenance.

Immediately before the flight the captain is usually busy settling fuel and airfield service bills, assessing the weather forecast at the destination and alternate airfields, and submitting a flight plan.

In the meantime, the co-pilot – possibly assisted by the flight attendant – is readying the aircraft. After the aircraft is filled with fuel and oils, the copilot conducts external inspection and checks onboard systems. The test consoles are fitted behind the copilot's right shoulder; the testing routine covers the entire range of preflight checks. The testing programme takes up not more than one hour, provided that fuel and other flight-critical stuff are delivered in time. The flight attendant's preflight task is to interact with the catering service, allocate baggage and cargo, and then accommodate passengers. The copilot controls the resultant balance and enters its value into the logger together with other flight-related data.

After the captain has entered the cockpit, the crew activates the preset route on the satellite navigation board, fastens seatbelts, and requests start-up clearance.

Preflight preparations may be assisted by ground power supply or by the onboard auxiliary power unit (APU). The An-140's APU is outstanding: during certification tests it was forced to start up the main engines at up to 7,200m above seal level, including at high ambient temperatures. Never before would an APU, designed to operate primarily on ground, demonstrate so magnificent high-altitude tolerance. No less miraculous was the An-140 APU's cold weather performance: it would start up at -40°C, with no preheating required. The APU proved to be capable of steady continuous operation during pre-flight preparations and the flight itself, providing the necessary power for the aircraft's electricity circuits, cabin heating/air conditioning systems, and engine startup compressed air system.

If the APU fails, an external source of compressed air may be used to start up one of the main engines. The APU itself can be started up using a ground power source or onboard storage batteries.

The onboard AC/DC system incorporates layered failure-resilient architecture. The generators of the main engines serve as the major power source. Either of the two generators can power virtually all onboard systems: whatever exceptions exist are powered by the APU's generator, including in severe icing conditions. The output of the APU's generator may be further increased in the near future to independently provide for all onboard electricity needs.

If both the main engines and the APU should fail, storage batteries will power onboard equipment for 20 minutes, quite enough time for a safe landing.

The cabin may be air-conditioned by an external unit, which is part of the airfield servicing equipment set. But the main source of cabin comfort is the onboard air conditioning system. This system was ground- and flight-tested in the ambient temperature range of +45 to -50°C, and never failed to provide high-quality air conditioning. This fact was registered by authoritative CIS laboratories and sanitation specialists that attended the certification programme.

COCKPIT LAYOUT AND CREW DUTIES DISTRIBUTION

An-140 designers were initially facing a dilemma: opting for LCD monitors vs. arranging the cockpit panel with use of customary instruments and indicators. This choice is not as obvious as it appears. With traditional pointer indicators planted 10 to 20cm apart, the pilots tend to perceive the entire instrumentation panel as an integral source of information and read positions of pointers using peripheral vision. But if you replace the entire instrument panel with an LCD monitor, the pilots will have to deal with a limited area holding all sorts of data, much of them displayed in the form of digits (which the pilots will actually have to read).

This is why the default An-140 cockpit panel incorporates standard pointer indicators, but the customer can opt for a different layout. All instrument panels are modular: instruments may be replaced, supplemented, or represent values electronically. The electronic cockpit panel is already available.

All instruments and controls in the An-140 cockpit are grouped ergonomically, based on priority of each system. Each group of indicators and controls is accessible from either pilot's seat, because the certification standards mandate that any of the two crewmembers must be able to safely land the aircraft on his own.

There are three variants of interaction between the An-140 pilots. With the primary technology, the copilot handles the landing approach all the way down to the decision height. The captain supports the approach, establishes visual contact with the ground and approach lights, then takes over the control and lands the aircraft. Another technology stipulates that the captain shall have constant control of the aircraft, with the copilot attending to communications, navigation, and system control. A third technology, available for training purposes, envisions arbitrary functional swaps between the captain and the copilot.

The functions of either crewmember are interchangeable, but the copilot's seat is better equipped for additional tasks. The copilot has at his disposal a foldable table and holders for maps and aeronautical reference publications. Either seat is fitted with overhead and portable lamps. In-built fans provide comfort, and overhead fans additionally blow over the windscreens.

The spacious cockpit glazing combines with comfortable seats to give the pilots the impression that they are hovering in airspace. This is essential to safety of flight in conditions most untypical of transport aircraft.

The cockpit glazing is electrically heated. The minimum settings are usually enough to deice the glazing, and the maximum settings can cope with any sort of icing. Melting ice gets swept away by incoming air or by the windscreen wipers.

The pilots have an excellent view of the front parts of the engines and of the wing's leading edge and lower plane. The crew can control power plant vibrations by merely watching how the propellers rotate.

TAKEOFF

An-140 systems are extremely easy to operate. For example, to start up the APU you only have to switch the ground power supply toggle (or two storage battery toggles), turn the APU automation switch, and wait for the "ready" indicator to light up. After that you just push the corresponding button, and the APU starts up.

Starting up the main engines with the help of compressed air is just as easy: switch on the three engine automation toggles, unlatch the propellers, switch on the APU air bleed toggle, push the corresponding light buttons on a mnemonic diagram, wait for the "ready" indicator to light up, and press the corresponding button. The two engines may be automatically started up one by one. The engine startup is performed in the "easy taxiing" mode.

After that the crew switches on the generators, rectifiers, and converters, checks the power network, and switches on all toggles on the two equipment panels located symmetrically over the pilots' seats. The "dark cockpit" concept implemented in the An-140 implies that all system notices are hidden from the pilots until they become critical. Yellow alerting signals are located on upper cockpit panels, and red emergency lighting is to be found on the overhang canopy, right in front of the pilots' heads. The crew then goes on with equipment checks.

The pilots extend to flaps to the 10° (or 15°) takeoff position. Three to five minutes later the crew uncages the gyro horizons and synchronizes them with the magnetic compass. This procedure takes different time depending on the ambient temperature. The crew reads the checklist and requests taxi clearance. After taxiing has been permitted, the crew switches on the landing lights to warn ground personnel and taxies to holding position. While taxiing, the pilots check the main and emergency brakes.

The nose landing gear is controlled with the help of pedals or steering column; no control switchover is required. The pedals are used for minor nose gear turns, and the steering column for major turns.

Taxiing is comfortable for passengers if the crew isn't swaggering. If the pilots miss a turn they can stop and avail of reverse thrust to return. Parking is equally easy: guided by an airfield engineer, the crew can steer

backwards to any parking site, even the most inconvenient one.

No additional operations are required in the holding and lineup positions. The crew can avail of the rolling start option and proceed for takeoff without holding on the runway. If time permits, however, it is advised that the pilots pump some oil through the propeller reverse system. Doing so only requires that the engines be turned a couple times from nominal thrust to reverse thrust and back again.

The power control levers are used for all power plant control purposes save for one: the propellers are unlatched using separate toggles. This is done merely for the pilots' convenience: crews still doubt the feasibility of incorporating this function into the power control lever.

The crew is warned about improper trimmer and flap takeoff settings with the help of a special indicator, a buzzer, and blinking red lamps. If none of the three is present, the flight is ready for takeoff.

With a liftoff speed of 180-210km/h and a run of 600 to 800m, the An-140 takes off like a shot. The exact liftoff speed and run values depend on the takeoff weight, the airfield's altitude, and the ambient temperature. In the hardest cases the aircraft's takeoff run does not exceed 1,200m.

Engine failure-related aborted takeoffs at liftoff speed result in an aggregate run/roll distance of 1,200 to 1,800m. Test pilots tested a multitude of situations with various braking methods, including with/without reverse thrust, with/without wheel braking, and with/without propeller unlatching.

Continued takeoffs with one failed engine resulted in a takeoff run of up to 2,000m and a post-liftoff climb gradient of 1.5-2m/sec.

A normal post-liftoff climb speed falls between 7 and 12m/sec. With nominal power the aircraft climbs at an instrument airspeed of 270-300km/h. By the time the aircraft with a takeoff weight of 21.5t climbs to cruise (7,200m) its vertical airspeed reaches 1.5-2m/sec; the vertical airspeed may be augmented through reduction of the instrument airspeed to 260km/h, an equivalent of the maximum lift at these altitudes. The aircraft's lift capabilities increase as it burns fuel.

The aircraft gradually speeds up to reach an instrument airspeed of 340-360km/h, which equals a true airspeed of 510-550km/h.

The aircraft was tested in strong and gusty winds. The wind speed would reach 27m/sec during test flights. Nevertheless, the engines would start regardless of the wind direction, and the aircraft would taxi normally at an aggregate speed equalling the takeoff speed. In this situation the crew had to largely avail of the air rudders to keep her steady while taxiing. The one mandatory condition during these tests was that the crew extended flaps only on lineup.

IN THE AIR

At cruising speeds the An-140 averagely consumes 600kg of fuel per hour, thus ensuring up to six hours of flight to distances of up to 3,200km; these parameters are constantly improving. A one-meter increase in the wingspan a 5% save in fuel consumption. Aerodynamic perfection of the engine pods provided a 3% increase in range. The designers' next goal is to ensure a range of 3,800km. Simultaneously, the project team is enhancing the aircraft's cruising speeds and altitudes.

The An-140 testing programme demonstrated a certain hysteresis in the aircraft's single-engine climbing ceiling (3,600m) and descent ceiling (4,600m). This discrepancy means that the required and actual thrust curves lie close to each other. In this situation even incremental additions in engine power or minor decreases in drag provide for a noticeable increase in the aircraft's ceiling, airspeed, and range.

The An-140's manoeuvrability is fairly impressive both near ground and at cruising altitudes. Across the entire range of altitudes the aircraft is well balanced in terms of the steering-attitude ratio. One peculiarity of the aircraft is the necessity of well-coordinated turns. Deflecting a pedal might give a greater effect than rotating the steering column; a very useful feature in many situations.

Near ground the An-140 behaves much like a fighter. It is capable of 60° pitch climbs, stalled turns, rolls, etc. All these features might prove essential in a wide range of operations.

The aircraft's fuselage is fully pressurized. Pressurization complies with physiological flight standards at altitudes of up to 9,000m. The aircraft's maximum cruising altitude is currently 7,200m. An An-140 with an unpressurized cockpit takes around three minutes to descend to a safe altitude with landing gear extended, and under four minutes with landing gear retracted.

Incremental pressurization and air conditioning controls allow the crew to optimise air bleeding, i.e. to reduce the required engine power and fuel consumption.

During certification tests pilots would repeatedly turn air bleeding off at altitudes of 7,200m and higher, which never resulted in any catastrophic consequences. Excessive pressure in the cockpit would at all times decrease very slowly, and the crew would always have five to ten minutes to run their tests before they would turn to oxygen masks. And the oxygen supply system never failed.

The aircraft incorporates a very efficient anti-icing system. It utilizes a so-called heat knife technology, which consumes very little energy to get ice to blown away along the entire unheated area of wing or empennage. This technology is nothing new, but its implementation proved so successful that the designers decided to save air bleeding on wing heating.

The system is activated and deactivated automatically. Partial and total system failures were checked during test flights: situations that result from such events may be complicated but never bordering on emergency. It's either the pilots get an icing warning or they detect icing visually, the field of view allowing for it. At nighttime the crew may use the landing lights to detect icing.

Natural icing tests were held in the interfluve of the Northern Dvina and the Pechora, in the icing epicentre of the Northern hemisphere. Severest cases of icing are found there, but the aircraft coped with them just as well.

In natural icing conditions you may find any sorts of ice varying in shape, size, and strength. At times ice takes up most fantastic shapes. But even experienced pilots awed at what specialists of Antonov Design Bureau attached to the An-140's wing by way of ice simulation for research purposes. What they did was glue palm-thick timber beams along the leading edges of wing and empennage. At first I though the aircraft would not take off at all, or would stall immediately after takeoff. Since the runway length allowed for two takeoffs and two landings, my copilot and me first tried 0.5-1m hops. The aircraft did behave, so we took off and proceeded to the test area. There we tested high angles of attack and stalling. Strange as it appeared, we managed to exceed the stalling angle maximum for the standard, "deiced" aircraft by an entire degree. The aircraft retained controllability even during deep sinking or factual freefall. In fact, because the aircraft did retain control it would be more correct to call this a separate piloting mode, not stalling.

Natural icing conditions corroborated our findings. Flying an ice-covered aircraft proved generally safer than exceeding the stalling angle in a normal condition.

The lucky wing profile choice (with no-slats, dull leading edges) allowed the crew to easily exceed the stalling angle attack. The aircraft has no problems reaching the peak of lift and then, with the steering column completely pulled, pecks and starts sinking with a minor right-turn speed. This right turn is accounted for by a corresponding 5° rudder deflection designed to make up for the jet reaction.

If you now keep the column pulled, the aircraft slightly speeds up, with its nose down, then raises the nose again only to lose speed and start sinking. This continues until you release the column, after which the aircraft immediately speeds up and returns to normal angles of attack. At increased power, during manoeuvring, and with one engine shut off no major changes were detected in the aircraft's high-angle-of-attack behaviour. Spontaneous banking would only be attained with elevators set to spinning. Such methods are sometimes used in aerobatics, but they are obviously inappropriate with the An-140 transport. You don't need them to realize that the aircraft is safe to fly.

The An-140 offers the full range of natural high-angle-of-attack tokens: airflow around the wing develops in stepwise fashion, in symmetrical zones. First you feel itching, then joggles, then shaking, and finally, vortex bumps against the empennage. With the landing gear extended, vortexes from the nose gear well door hit against the fuselage right under the pilots' seats – all this long before the actual stalling.

Designers enhanced the natural maximum-angle-of-attack tokens by connecting a vibrator to the steering column and supplementing it by audiovisual signalisation. The cockpit is additionally fitted with an angle-of-attack and g-force indicator.

The hydraulic system retracts/extends the landing gear and flaps, provides for main gear braking, ensures the steering of the front gear leg, and automatically extends spoilers to trim in case of an engine malfunction. The system receives service pressure from a pumping station and a hydraulic accumulator. The pumping station is activated/deactivated manually or automatically. Test pilots simulated hydraulic system failure and found no problems with aircraft control.

LANDING

The aircraft typically descends to the traffic circling height an instrument airspeed of 300km/h, but the crew may also maintain an airspeed of 420km/h. The maximum tested instrument airspeed amounts to 520km/h. The vertical g-force is limited to 2.4 G, but the aircraft was tested at the limit of 3 G. The negative g-force is restricted to 0 G, although the aircraft was successfully tested at –0.5 to –0.7 G.

The permitted gear retraction airspeed amounts to 360km/h; flaps can be extended to 15° at 320km/h to greater angles at 260km/h.

The circuit operation speed depends on the given airfield. Outside reduced noise areas, the approach speed is 210-230km/h with flaps at 25° and 180-200km/h with flaps at 40°.

The aircraft is stable on approach and requires minimal control. The alignment and landing process is simple even to novices. You can certainly feel the ground cushion effect, but it doesn't affect the landing in any sufficient way. The An-140 lands at a speed of 170-190km/h with flaps at 25° and at 160-170km/h with flaps at 40°. But the speed loss is higher when aligning with flaps at 40°, which requires a reserve of thrust or timely and energetic steering column actions once the ground cushion effect has disappeared. If the pilot has been too busy aligning and switched the power control level to flight idle, then reaction alone may prove insufficient to compensate, and the landing will be rougher than usual. On the other hand, nobody expects a mild landing with flaps at 40°.

After the main gear legs touch down the crew gradually lowers the nose gear, sets the power control lever to ground idle, then unlatches the propellers (the right-hand moment follows), and turns to reverse thrust. The roll does not cause any problems. Its length depends on the touchdown speed and the braking method used: unlatching the propellers, reversing the thrust, or braking the main gear. Extended flaps and deflected elevators (the direction of deflection is immaterial) also affect the roll length. The pilots may choose to brake by keeping the nose up for as long as possible. Naturally, the efficiency of braking against air reduces as the airspeed decreases, whereas the efficiency of wheel brakes increases as the speed decreases.

Depending on the landing weight, the airfield's altitude, and the ambient temperature, combined braking with full strut compression would yield a roll of not more than 300-600m.

All separate braking variants and every possible combination thereof have been tested, including during simulated engine-failure landing. Main gear wheel brakes were especially efficient, but any braking combination would demonstrate a roll distance under 1,300m.

The An-140 was test-landed on unpaved runways with soil consistency equalling 8kg/cm2, on dense and fresh snow, on dirt and ice-covered artificial runways.

Each runway type had its peculiarities, but none offered impossible challenges. Any of the tested runways, under all aforesaid runway conditions, would yield takeoff run and landing roll distances keeping within 1,800-2,000m (aborted and continued takeoffs included). The airfield's altitudes were up to 3,000m above sea level, and the range of ambient temperatures was between -50 and +45oC. The runways themselves varied in quality, but the propeller clearance would easily overcome knee-high grass, and wide, large-diameter low-pressure wheel tires easily coped with ditches and gopher holes.

Asphalt/gravel runways are the major artificial runway type at local and regional CIS airfields. Today they are more gravel than asphalt. Karakol Airport in Przhevalsk, Kyrgyzstan, which was chosen as the base for the high-altitude An-140 flight testing programme, may by right be called a record-setter in runway degradation. It is probably only surpassed in the poor runway quality by the Batagai airfield in Yakutia, whose designers did without asphalt altogether and simply pressed gravel into permafrost.

It was in Kyrgyzstan and Yakutia that we tested the An-140's engine and airframe vulnerability to gravel. We used unrestricted reverse thrust to lift gravel (and also dust, snow, ice, and dirt) off the runway and into the air right in front of the aircraft. These experiments resulted in no detriment to the An-140, save to minor damages to the paint coat. The engines did not show any signs of damage, either.

The An-140's engines were selected largely because of this high tolerance and survivability. The TV3-117VMA engine used to power combat helicopters in the Afghan and Chechen wars and survived through all accompanying field operation nightmares. The TV3-117VMA-SBM1 variant mounted on the An-140 "swallows" ice and gravel, which come blade-shattering right through it, but none of the engine's parameters changes.

The engine equally behaved in other extreme conditions. It would readily start up at any airfield, in hot and cold weather, in all altitudes, including in icing conditions. It would bear many hours of emergency power, which would have caused other engines to fail in mere minutes. It would allow for air bleeding that would have killed any Western-made engine. It also tolerated oil shortages, takeoff power at cruising altitudes, and a number of other "niceties".

The main merit of the engine is that its gas generator has long been in mass production, i.e. is cheap to manufacture. Electronic control of the TV3-11VMA-SBM1 engine provides for just 600kh/h of cruising fuel consumption. If the electronic engine control system fails, an auxiliary hydromechanical control system is activated; this system offers slightly greater fuel consumption but is highly reliable and completely immune to electromagnetic interference.

The multiple-lade AV-140 propeller merits a special comment. Relatively small scimitar blades provide the required thrust and produce very little noise. These blades have demonstrated outstanding survivability under influence of dust, small gravel, and ice pebbles. Even with the propeller extensively damaged by gravel, the crew can repair it by filing jagged edges down and filling apertures with special paste. Propeller vibrations then remain within acceptable levels.

The testing programme was rich in changing winds with 30˚ gusts and wind speed of up to 40km/h. The wind would change direction 180˚ within a range of 70 to 300m above ground. The crew might approach downwind right down to the inner beacon, and then land upwind – not to mention constant mighty windshears. That was an extended squall virtually impossible to fly in.

The aircraft coped with this extreme weather conditions, once again demonstrating its outstanding manoeuvrability and excellent acceleration characteristics of the engines, which ensured timely compensation for instantaneous changes in wind direction and wind force.

The tests proved the old wisdom that at strong gusty crosswind of up to 15m/sec it is mandatory that the aircraft's centre-of-gravity vector should be oriented strictly along the runway axis. If this is so, then the aircraft is feathered along the runway and is kept within the set limits with acceptable control surface adjustments, rotation of the nose gear leg, and asymmetric wheel braking. In emergency cases the crew may avail of asymmetric thrust or resort to short-term symmetric thrust (up to the takeoff power level), thus increasing the feathering effect along the runway axis. This is what the An-140's long wheelbase and narrow gear wheel gauge are meant for.

In case of emergency landing, the aircraft is controlled by very simple automatic analogous systems. It took us many flights and much patience to select the right approach algorithms until the systems finally began to infallibly guide the aircraft right to the runway, where the ground cushion effect moves the An-140's nose upwards. The aircraft then automatically lands at fairly acceptable g-loads. The emergency landing mode was tested during the certification testing programme. The automatic landing system may miscalculate the ground effect and damage the aircraft beyond reasonable repair, but even in this case all passengers will survive. Activation of the automatic landing mode only requires pressing several mnemonically understandable buttons on the control panel, which might be done by a passenger or the flight attendant.

The An-140 is generally emergency-tolerant. For example, the aircraft easily lands after passing over the outer marker at 500m or even 600m above ground – and this is only four kilometres to the threshold! We tried such approaches even at nighttime, in clouds, and did not experience any inconveniences save for emotional agitation.

Test pilots would simulate approaches with obstacles on the final leg. The aircraft would reach the threshold at an angle of more than 60˚ to the runway axis, and still landed exactly where planned. The An-140's stalling tolerance allowed the crew to perform steep turns and slides at approach speeds to eliminate any pre-landing mistakes.

Not that there are any problems with missed approach operations. Certain complications would emerge only if the crew decided to go around with one engine shut down and with flaps at 40˚, but even then the pilots had several options, the simplest one being to increase the approach speed by 10km/h. This recommendation is hardly useful in linear approaches, when the crew typically maintains increased speeds right down to the threshold to overcome possible windshears.

According to the requirements of the certification standards, an entire range of standard failure situations were run on the An-140, including destruction of one engine and control cabling severance by blade splinters. In these situations the crew would land without use of elevators, i.e. only availing of the trimmers and adjusting the thrust of the one remaining engine.

All this proves that that the An-140 is simple, reliable, and safe.

Ukrainian Ministry of Defence State Enterprise

LUGANSK AIRCRAFT REPAIR WORKS

Alexei Mostovoy, Director

Quality. Reliability. Guarantee.

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- Overhaul, after-sales – post-warranty service of all modifications of the TV3-117, TV2-117A(AG), R29(B)-300 and R35-300 engines.
- Overhaul of relay ladder logic, fuel, oil and air system components of the above engines.
- Training of technicians in operation and repairs of aviation materiel.

Repair mastering of the VR-8A, VR-14 helicopter main reduction gear is being undertaken.

The works was re-certified to the new version of the ISO 9001 – 2000 standard in July 2002.

The Lugansk aircraft repair works has secured contracts with manufacturing plants and design bureaux for design-engineering support of aircraft repairs.

OAO Motor Sich and SNPP Yupiter project representatives acknowledged on 2 August 2002 that the Lugansk works carried out repairs in accordance with the existing repair documentation.

The works' employees cherish the history of aviation, willing to preserve tradition and lay the foundation for the future. To this end an aircraft museum, numbering over 60 exhibits, was established at the works in 1996.

LUGANSK-4,
91004, UKRAINE
Tel +38 (0642) 42-88-17
Fax: +38 (0642) 42-77-74

TARGI KIELCE

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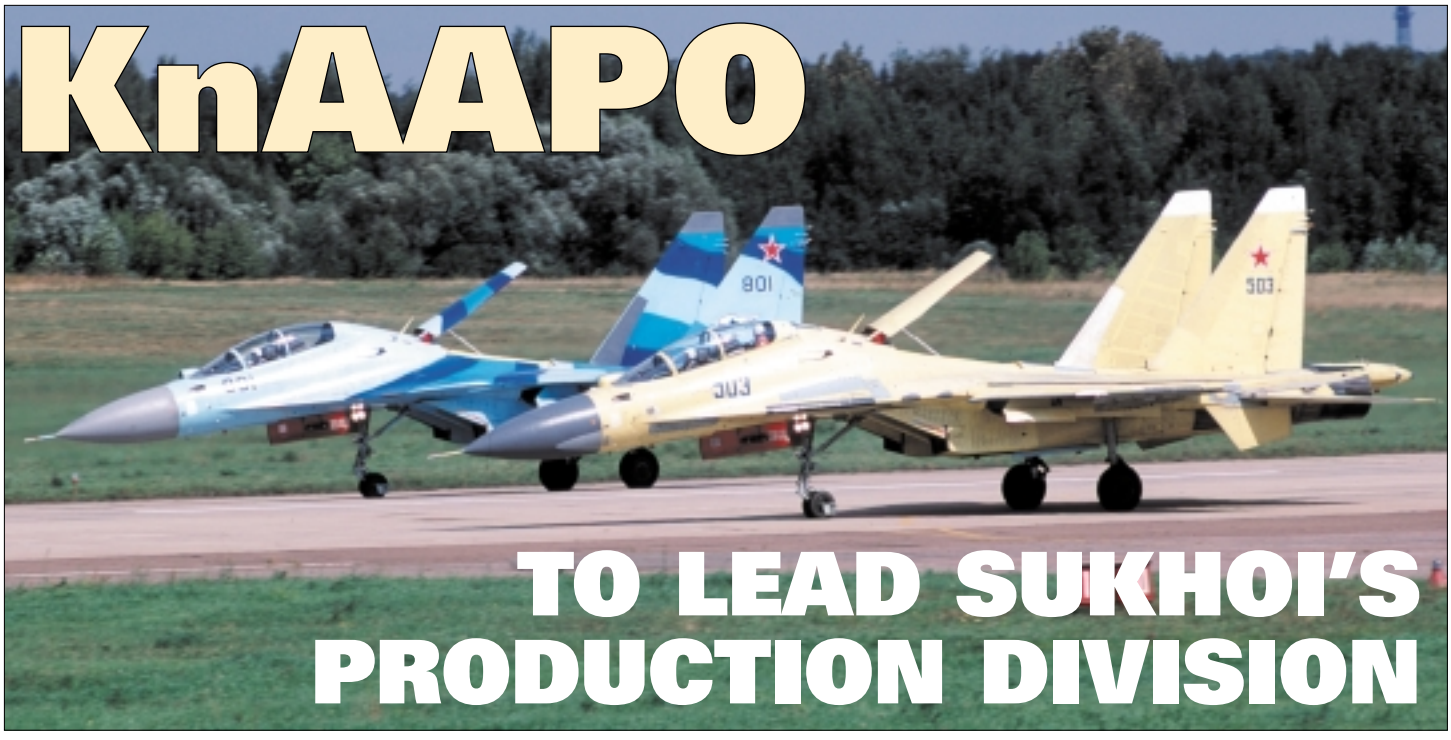
TARGI KIELCE
Kielce Trade Fairs Ltd. 25-672 Kielce, Poland , Zakładowa 1, telephone +4841 365 12 98, 365 12 89, fax +4841 365 12 79,
e-mail: mspo@ctk.com.pl; prostak.k@ctk.com.pl; mlynarczyk.m@ctk.com.pl; www.mspo.pl; www.targikielce.pl
Warsaw Agency: 00-074 Warszawa, Poland, Trębacka 4, telephone +4822 630 96 16, fax +4822 826 00 42, e-mail: warszawa@targikielce.pl

KnAAPO



TO LEAD SUKHOI'S PRODUCTION DIVISION

In late 2002 Komsomolsk-on-Amur Aircraft Production Association (KnAAPO) Federal State Unitary Enterprise was converted into a joint stock company. Under the Russian president's decree on the establishment of the Sukhoi Aviation Holding Company dated October 2001, as many as 74.5% of KnAAPO's stock will go to Sukhoi company. The holding is to be formed in the first half of 2003. It will include, apart from KnAAPO, the Sukhoi Design Bureau, Beriev company and aircraft production plants in Novosibirsk and Irkutsk. Given the level of development and technological background, KnAAPO is likely to become the primary production force of the future Sukhoi company.

KnAAPO will turn 70 next year. Over these years the company has mastered production of more than a dozen types of combat and civil aircraft, and a great many of their modifications, as well as sea-launched missiles and other kinds of equipment. KnAAPO has been building Sukhoi warplanes for about half a century.

Having made the first variant of the Su-7 supersonic fighter, KnAAPO became the only manufacturer of Sukhoi jet fighter-bombers in the USSR, them being the Su-7B and Su-17/Su-20/Su-22. As many as 5,000 of such aircraft were built within 30 years; some of them are still in service. Those planes were the first step of KnAAPO on the way to international recognition as a manufacturer of quality warplanes.

The company has a 45-year experience in the international market, during which time it exported over 2,000 Sukhoi aircraft to a score of countries. Today KnAAPO is a leading Russian aircraft exporter. Currently, the company sells abroad Su-30MK multirole twin-seaters. Their series production was mastered in 2000, and now they are supplied in large batches.

The Su-30MK is a development of the Su-27 fighter produced by KnAAPO since 1982. These single-seaters are now the backbone of the Russian Air Force and air forces of a number of CIS nations. The Su-27SK export modification has been supplied to China and Vietnam since 1992. Furthermore, KnAAPO was the only enterprise to build Su-33 ship-borne fighters for the Admiral Kuznetsov heavy aircraft carrier, and later a significantly upgraded Su-27KUB twin-seat variant.

Following the Su-30MK programme, KnAAPO is to pass over to construction of more advanced multirole and highly manoeuvrable 4+ generation fighters like the Su-35. According to analysts, such machines will be given priority in the export of Russian combat aircraft in the coming 10-12 years, until a future fifth generation Sukhoi fighter becomes available. It has already been decided that KnAAPO will be tasked with production of the future fighter, which means that the Russian Air Force's hopes, as well as those of arms exporters are pinned on the company. Series production of the future fighter is expected to start in 2010, but KnAAPO will actively participate in manufacturing of the aircraft prototypes.

But mastering production of new variants of the Su-27 family is not the only thing KnAAPO is good at. It has been appointed parent enterprise to repair and upgrade ageing aircraft. The company has been overhauling Air Force's Su-27s since 1996. Furthermore, under the programme, approved by the Air Force, the Komsomolsk-on-Amur Aircraft Production Association in 2002 started upgrading in-service aircraft to the 4+ generation level. The resulting upgraded Su-27SM, an aircraft taken from an Air Force fighter regiment, entered the test phase in December 2002. Early this year the initial Su-27SM will undergo the necessary tests at the Air Force State Flight Research Centre to be later returned to the regiment, while a number of similar machines will follow suit.

Also, KnAAPO has been repairing Su-33 ship-based fighters from the separate carrier-borne regiment of the Northern Fleet since 2000. In 2002 the company started modernising navalised fighters by equipping them with advanced systems.

However, KnAAPO does not restrict the sphere of its interests to production, repairs and modernisation of combat aircraft only. For over a decade the aircraft manufacturer has been pursuing civil and dual-purpose programmes.

Today there are two such programmes: production of the Be-103 lightweight amphibian and the Su-80 multipurpose transport.

The Be-103 was designed by the Beriev company that relied on the wealth of experience gained through years of designing various sorts of hydroplanes. AP-23 and FAR-23-compliant Be-103 can be employed on short-haul routes in areas rich in water basins, and thus inaccessible to other means of transportation.

The basic advantages of the Be-103 include:

- aerohydrodynamic configuration with water displacing, non-high-lift low wing. Large leading edge root extensions provide stability in water and ensure surface effect at take-off and landing;

- all-metal airframe made of corrosion-resistant materials with wide use of aluminium-lithium alloy;

- power plant consists of two reliable US-produced piston engines with puller propellers mounted on horizontal pylons on either side of the fuselage over the rear centre wing section, which prevents water sprays from getting into engines at take-off and landing;

- retractable tricycle landing gear with nose wheel. The wheelbase and undercarriage track are rather large, facilitating operation from unprepared airfields;

- quite impressive sea-going ability for amphibians of the type (Sea State 2, wave height up to 0.5m);

- comfortable cabin for five passengers;

- state-of-the-art piloting/navigation equipment rendering the amphibian round-the-clock and all-weather capable;

The first amphibian was built in 1996, with the maiden flight performed on 15 July 1997 by test pilot Vladimir Ulyanov. A total of five flying Be-103s have been manufactured by now. In 2002 KnAAPO embarked on production of the first batch of three Be-103 amphibians to be shipped to the USA. The Be-103 was successfully certified to the Russian AP-23 standards, with the type certificate awarded on 26 December 2001. The year 2003 will see FAR-23 certification, a move aimed at winning over foreign customers, which is hardly surprising, since the plane is vary popular the world over.

The baseline cargo/passenger variant is intended for transportation of 4-5 people or up to 400kg of cargo. The amphibian can be produced in other variants, such as patrol, medevac, training and agricultural. The Be-103 is also suited for forest fire monitoring, as well as for surveying oil and gas pipelines and power lines.

Except production and modification of the baseline Be-103 amphibian, KnAAPO has developed it into the SA-20P lightweight six-seater fitted with one M-14P piston engine burning cheaper gas. Flight tests, commenced in October 2002, proved the design characteristics. The SA-20P is believed to attract Russian customers.

KnAAPO's another programme in the realm of civil aviation is the Su-80 multipurpose transport designed by the Sukhoi Design Bureau. It was due to both long-term business relations and the high level of workmanship that Sukhoi chose KnAAPO as the Su-80 manufacturer. What's more, considering possible ways of product line diversification in the early 1990s, KnAAPO was ready to invest in the Su-80 project drawing on profits gained through export of the main product, the Su-27SK fighter.

The main features of the Su-80 are as follows:

- unconventional twin-boom airframe design with a large hatch in the rear fuselage facilitating cargo loading and passenger entrance;

- economical and reliable power plant comprising two General Electric CT7-9B turboprops, each developing 1,750hp and fitted with Hamilton Sundstrand propellers;

- sophisticated PNK-80 piloting/navigation system designed by the St. Petersburg-based Elektroavtomatika Design Bureau;

- ability to operate from unprepared airfields with short runways.

KnAAPO started mastering production of the Su-80 as early as 1994. An aircraft for static tests and a full-scale mock-up were built in 1997, while the first flying prototype was assembled in 1999. The maiden flight took place on 4 September 2001 with test pilots Igor Votintsev and Yuri Vashchuk at the controls.

The first flying Su-80GP was made cargo/passenger to carry 30 people or 3,300kg of cargo. The prototype has completed the first stage of flight tests proving all the design parameters. The aircraft was then debugged at Sukhoi's facility in Zhukovsky outside Moscow to eliminate minor drawbacks highlighted by flight tests. One more crew of test pilots (Evgeny Frolov and Sergei Kostin) has been prepared to continue testing the machine.

KnAAPO is completing preparations for the Su-80's mass production. The airframe of the second debugged and enhanced flying Su-80GP prototype is almost ready, with plans for flight tests in mid-2003. Two more flying prototypes are being constructed to bring the number of aircraft participating in flight certification tests to four. The tests are to be completed by late 2004.

By August 2002 some 15 Russian carriers had expressed their interest in acquiring a total of over 60 Su-80GPs with delivery terms up until 2010. The aircraft stands just as good chances in the world market, especially in China, India, Indonesia, Malaysia, etc. The demand for the Su-80GP in the coming years is estimated at 50-70 aircraft. Another possible customer is the Russian Defence Ministry. The aircraft designers have offered their Su-80GP conceptual design proposals for the Russian Air Force future light transport competition. The baseline model can be transformed into a number of special-to-role modifications for a variety of missions, such as patrolling, assault support, navigator training, medevac, etc.

Extensive experience in building sophisticated combat aircraft, manufacture of civil planes, unrivalled production capabilities backed by up-to-date equipment, and recognition the world over cannot but guarantee KnAAPO's leadership in production of cutting-edge combat and civil planes, making it central for the Sukhoi company production division.

Andrey FOMIN

558th AIRCRAFT REPAIR PLANT

QUALITY GUARANTEED

The town of Baranovichi is a large industrial centre and a major transportation junction in western Belarus. Favourable location of the town on the 'east-west' and 'north-south' international routes contributed greatly to the development of its infrastructure. Furthermore, it is a significant aviation centre of Belarus. Apart from the republic's Air Force base, the town has the 558th Aircraft Repair Plant (ARP) Republican Unitary Industrial Enterprise that majors in repairs of modern combat aircraft in service with both own Air Force and air forces of foreign states. Moreover, the plant repairs planes of air carriers.

Today's 558th ARP is a dynamic enterprise employing skilled personnel, boasting up-to-date production facilities and operating state-of-the-art equipment.

The plant has a long history of military and technical cooperation with foreign states. It used to repair aircraft in service with air forces of Poland, the German Democratic Republic, Bulgaria, Hungary, Czechoslovakia, etc.

Currently, the enterprise is licensed to independently carry out foreign economic activities, which contributes to its positioning in the world market.

The 558th ARP repairs and offers post-repair servicing both at its own facilities and at aircraft deployment bases. At the customer's request a group of skilled and fully outfitted specialists is ready to get to the required site throughout the globe to carry out the required servicing.

Aircraft, repaired by the plant, are subject to warranty whose cost is included in the initial contract. If required by the customer, the 588th ARP can supply spare parts and components.

The training centre, set up with the plant, offers theoretical, flying and simulator training for pilots, maintenance training for ground personnel, while repairs specialists are taught the latest trends and methods of repairing various types of aircraft, avionics suites and weapon systems.

Nowadays, the plant is focused on repairs of Su-27 and MiG-29 fighters, Su-25 attack aircraft, and Su-17 (Su-22) family fighter-bombers. Skilled personnel, test benches and sophisticated equipment allow the plant to guarantee quality repair and servicing. Connecting success with further enhancement of production technology, the plant is carrying out comprehensive renovation of its production capacities, while introducing new technologies.

At the request of a foreign customer, the 558th ARP has teamed up with Sukhoi attack aircraft JSC to upgrade the Su-25UB attack aircraft, which considerably increased the aircraft's combat potential.

To raise the plant's chances in the international aircraft repairs market, the 558th ARP got certified to ISO 9002 standards. It also prepared an electronic catalogue of MiG-29 parts complete with an order form for spare parts and components. The approach is meant to streamline foreign economic activities through eliminating ambiguity when referring to a specific part or component.

The 558th repair plant repairs avionics, making use of test equipment and test benches. The plant's specialists developed workstations that help locate malfunctions in N019 and N001 radar components. Also repaired by the plant are laser range finders, gyros, and automatic control systems. The enterprise's another domain is repair of on-board artillery pieces and the complete inventory of ordnance.

Fabricated rubber products account for a large portion of parts replaced during repairs. To speed up the repair process, the 558th ARP employs own capacities to perform computer-aided design and production of press moulds taking advantage of numerically controlled machine tools and electro discharge machining. The plant also has a workshop producing fabricated rubber products, which fully satisfies its needs.

The drive of the 558th repair plant to improve technology and increase quality of produce is achieved through cooperation with the Russian VIAM institute of aviation materials and research institute of elastomeric materials.

Together with Gomel State University the plant has worked out and introduced laser welding technology for components repair and recovery, and later filed were three patent applications.

Aircraft repair is finalized by acceptance flights carried out by Class 1 test pilots. The plant's flight research station is equipped with stands for ground testing and computers registering flight parameters.

Repairs of the An-2 general-purpose aircraft has been mastered as part of the plant's conversion programme. The enterprise has been certified be able to extend the service life of the An-2 plane that has an outstanding record of service for the benefit of agriculture of many countries, and keeps ranking high in the field. Recently the plant started repairing Mi-8/17 and Mi-24 family helicopters that make up a large fleet of rotorcraft.

Clever marketing coupled with traditionally balanced relationships with customers opens up good prospects for the 558th Aircraft Repair Plant both in the CIS and international markets.

Nikolay VALUEV

558 AIRCRAFT REPAIR PLANT

We offer to our Customers:

Overhaul and upgrading of MiG-29, SU-27, SU-25, SU-22, AN-2 aircraft and their versions

Overhaul and upgrading of Mi-8, Mi-17 and Mi-24 helicopters

Repair of control and measuring systems, used in aircraft service

Repair of units of hydraulic, fuel and air systems

Repair of completing items of aircraft equipment, weapon, radar, communication and navigation equipment

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Postrepair service of equipment, delivered to the Customer

Delivery of spare parts and completing items for operation and repair of aviation materiel

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ENGINES FOR TRAINER AND LIGHT FROM

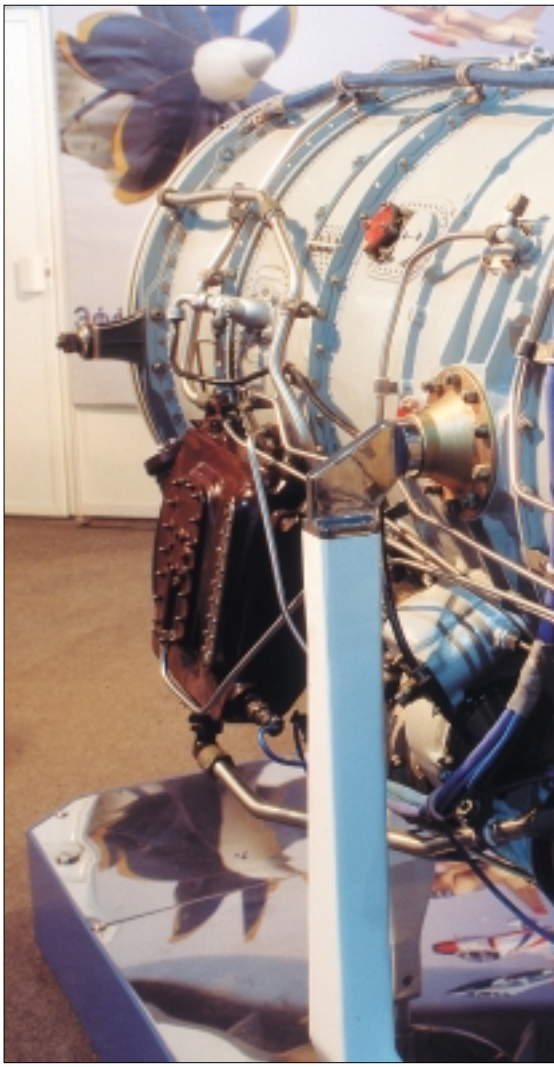
Fyodor Muravchenko,
Designer General,
Ivchenko-Progress Machine-building Design Bureau

The Zaporozhye-based Ivchenko Progress Machine-building Design Bureau boasts over 50 years of expertise in development, refinement, and modernisation of engines for trainer and combat trainer aircraft: in 1947 the design bureau developed the AI-10 piston engine for the Yak-20 aerobatics airplane; the AI-14 (M-14) piston engine, developed in 1948 and still in production, is widely used on aircraft like the Yak-12, Yak-18, Yak-50, Yak-52, Yak-53, Yak-55, Su-26, PZL-101A Gawron, PZL-104 Wilga 35, CJ-6A and their modifications, including the newest Yak-54, Su-29, and Su-31 sports aircraft.

For 35 years now Ivchenko-Progress Design Bureau has been developing jet engines for trainer aircraft. In 1971, the design bureau combined the production AI-25 turbofan engine (that was powering Yak-40 passenger jets) with the AI-25T turbofan, then under development for the Sukhoi T-8 ground attack aircraft project (which later became known as the Su-25), to design the 1,720hp AI-25TL turbofan engine. The AI-25TL was designed to power the Czech-made L-39 trainer, which was selected as the common jet trainer type for all Warsaw Pact countries and was later exported worldwide. In 1973, after official trials, the Zaporozhye-based Motor Sich Plant launched AI–25TL production.

Zaporozhye engineers have built around 5,000 AI-25TL engines over the past 30 years; the aggregate operational time of these engines now exceeds six million flight hours. The AI-25TL's high reliability can be illustrated by the following example: the 1996 and 1997 ratio of unscheduled engine removals per 1,000 flight hours amounted to only 0.11. AI–25TL engines currently power trainers and combat trainers in 37 countries. Nearly 3,000 L-39 aircraft built by Czech company AERO Vodochody, including the ubiquitous L-39C trainers and also L-39ZO and L-39ZA combat trainers, are fitted with these engines.

Ivchenko Progress engineers drew upon the AI-25TL experience in developing, by request from the Czech aircraft manufacturer, the 2,200kgf DV-2 engine to be mounted on the L-39's derivative, the L-59. The DV-2 was ready by the late 1980s and was handed over for production to the Slovakian Povazske Strojarne plant. In the 1990s DV-2 turbofan was modified to power Russia's new-generation Yak-130 trainer. The Yak-130D demonstrator powered by a pair of DV-2S turbofans completed its first flight on 25 April 1996.



AI-25TLSh

In 2000 the Ivchenko-Progress Design Bureau also started efforts to enhance performance of the baseline production AI-25TL engine.

The upgraded engine, dubbed AI-25TLSh, features increased maximum power and reduced low-altitude acceleration time. AI-25TLSh-powered aircraft are expected to get enhanced manoeuvrability and increased maximum take-off weight; safety of low-level flight and manoeuvring will also increase. The new engine will extend the trainer capabilities of the baseline L-39 and its L–39ZA and L–39ZO versions, and will enhance the aircraft's combat efficiency in the altitude range of 50m to 2,000m, including in high ambient temperature environments.

COMBAT AIRCRAFT
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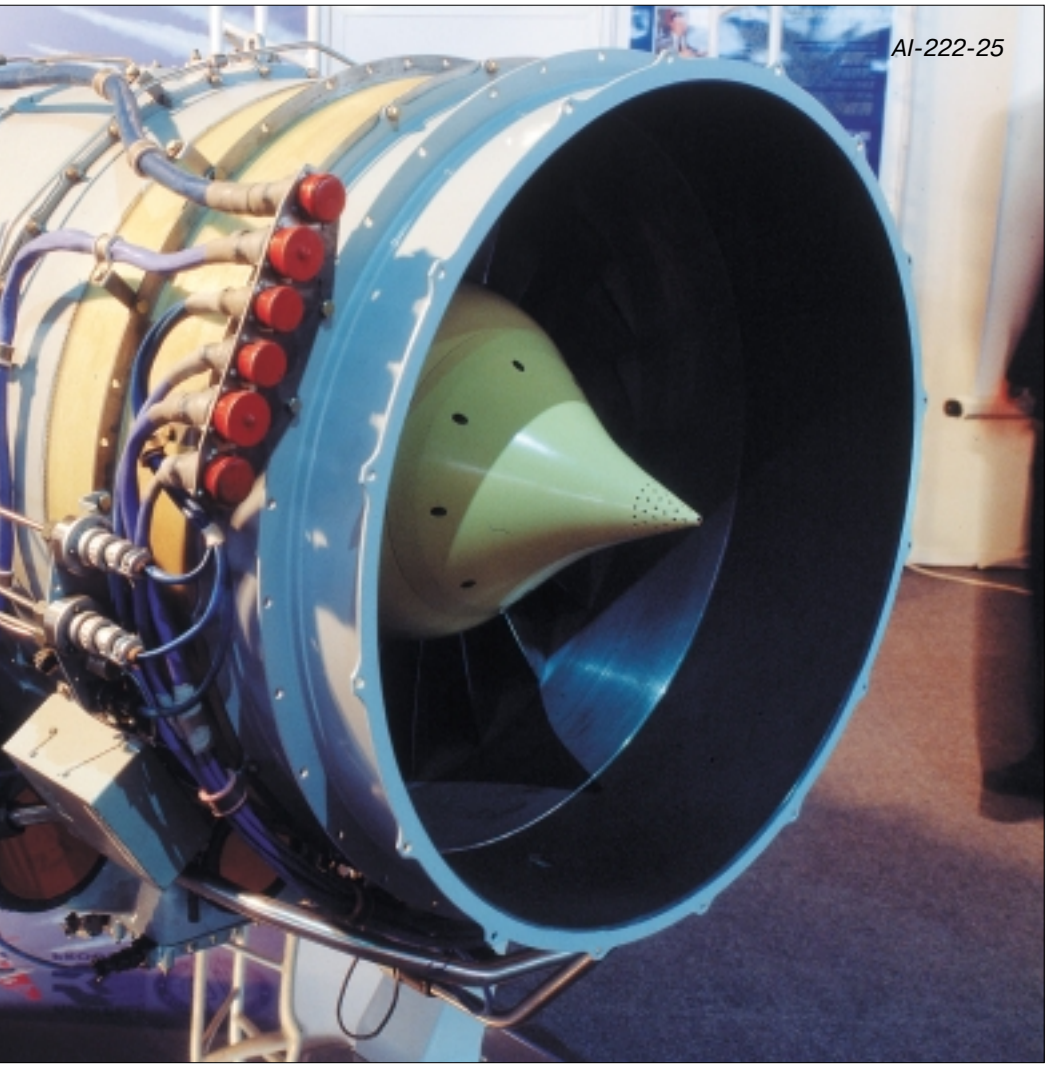

AI-222-25

Experimental and control tests run on three AI-25TLSh engines that had been built by late 2002 registered a two-fold reduction in acceleration time (from 9-12 to 5-6 seconds) and a 7.5% increase in static thrust (from 1,720kgf to 1,850kgf), which is equal to 1,720kgf of thrust at an ambient temperature of +30°C.

The year 2002 saw installation of the upgraded AI-25TLSh engine on a Ukrainian Air Force L-39. The aircraft completed its first flight on 13 June 2002. A research team with the Ukrainian Armed Forces State Flight Research Centre ran a flight testing programme on the re-engined trainer; the tests' results proved an essential increase in the engine's parameters over the baseline model.

Research conducted on the AI-25TLSh engine demonstrated the expedience of fitting it on all L-39 versions, and also on other types of trainer aircraft.

So, given the Indian Air Force's extended experience in operation of Ivchenko-Progress-developed AI-20D engines on An-32 military transports (the design bureau also developed AI-20M turboprops that power the Indian Navy's Il-38 ASW aircraft, and D-136 gas-turbine engines mounted on India's Mi-26 military heavy-lift transport helicopters), Zaporozhye engineers would like to draw attention of the Indian prospective trainer HJT-36 developers to the upgraded AI-25TLSh turbofan.

Furthermore, Ivchenko-Progress is developing the new-generation AI-222 turbofan engine family for prospective trainers, combat trainers, and light combat aircraft.

The AI-222 family is built around the gas generator of the AI-22 turbofan engine with 3,850kgf thrust, currently under development in the interests of the Tu-324 regional passenger jet programme. The first static test of the AI-22 gas generator took place on 28 April 1999; the full-size AI-22 engine demonstrator was first tested on 26 September 2000.

The decision to use the AI-22 gas generator as the core of the AI-222 engine enabled the developing team to compress the design phase period and the test demonstrator entered static testing in 2002. The AI-222 differs from the AI-22 in a new fan and low-pressure turbine modules and modified accessory box and nozzle.

The baseline AI-222-25 engine with 2,500kgf thrust is meant for installation on Yak-130 combat trainers ordered by the Russian Defence Ministry in 2002. The first AI-222-25-powered Yak-130s are expected to enter the flight test programme in the summer of 2003.

Motor Sich JSC and the MMPP Salut Moscow Machine-building Production Plant will team up to build AI-222-25 engines for Yak-130 combat trainers. The enterprises started work on the first batch of these engines in 2002.

Developers of the AI-222 family were set the critical task to ensure maximum flight safety and high combat efficiency of aircraft to be powered by these engines. The AI-222 engine has a guaranteed long service life and low operational cost.

The AI-222-25's high performance will combine with the excellent aerodynamics of the Yak-130 to offer high manoeuvrability at subsonic speeds and make the new trainer equal in flight parameters to fourth- and fifth-generation fighters. Apart from the Yak-130, which won the Russian Defence Ministry's tender and was recommended for fielding by the Russian Air Force, engines of the AI-222 family might be mounted on a number of upgradeable and emergent Russian and foreign aircraft.

To best suit the needs of different customers, Ivchenko-Progress uses the baseline AI-222-25 engine to develop an entire family of reliable and economical turbofan engines with thrust ranging between 2,500kgf and 5,000kgf. Below are some of these modifications:

- AI-222-25F – an afterburner version of the AI-222-25 turbofan with 4,200kgf take-off thrust (thrust augmentation ratio = 1.68): for trainers, combat trainers, and light combat aircraft with a maximum airspeed of M=1.5;
- AI-222-25KFK – a modification with the "short" afterburner featuring 3,000kgf take-off thrust (thrust augmentation ratio = 1.2): for aircraft that avail of only one afterburning mode;
- AI-222-25UVT – a thrust vector control version of the AI-222-25 turbofan;
- AI-222-28 – a non-afterburning version with enhanced thermodynamic cycle parameters; this modification has take-off thrust increased to 2,800kgf (may be increased to 3,000kgf in future);

Thanks to their optimal thrust and efficiency characteristics, low noise and emission levels, long service life, and low maintenance cost, engines of the AI-222 family will contribute to the creation of a range of highly competitive aircraft.

COMMERCIAL

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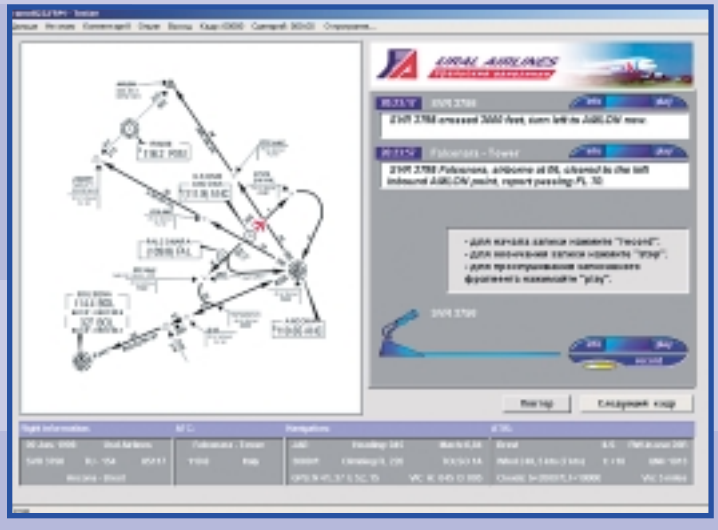
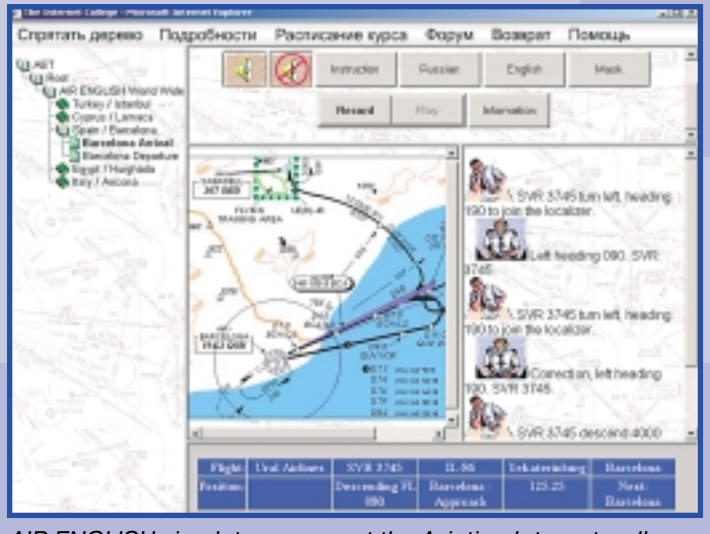


AIR ENGLISH simulator screen



AIR ENGLISH simulator screen at the Aviation Internet-college

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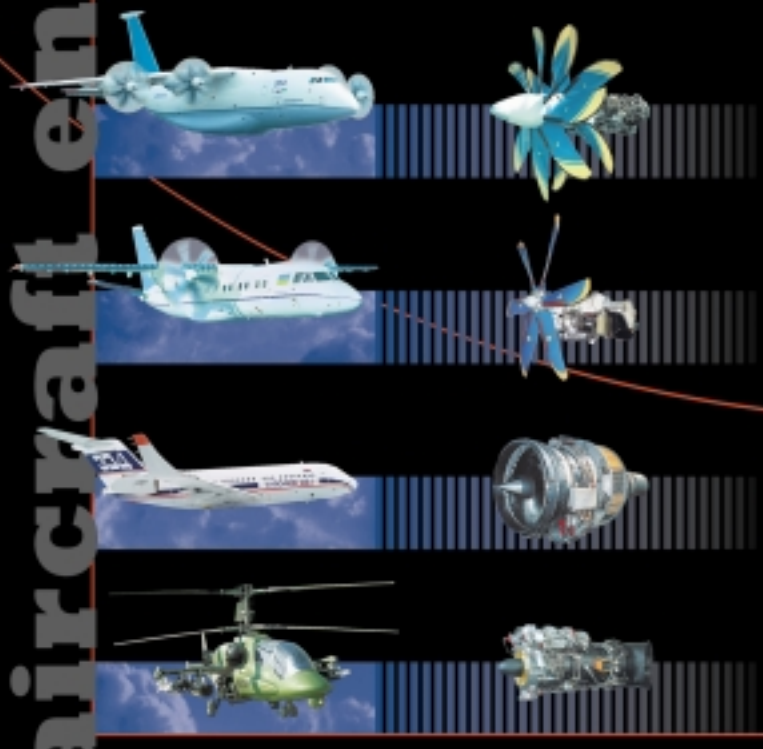

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A FAREWELL TO ZHUHAI

AirShow China 2004 may be held in Shanghai or Beijing

The 4th International Exhibition AirShow China 2002, held on 4-7 November 2002 in Zhuhai, was not rich in sensations: even the flight display was cancelled, apparently as a security precaution before the 16th congress of the Chinese Communist Party, which opened on 8 November.

According to rumours that circled the Zhuhai backstage, the show failed to compete with the Malaysia and Singapore forums. AirShow China 2004 might therefore be held in Beijing or Shanghai, a move believed to raise the exhibition's status. Apparently, this was the last time Zhuhai hosted the event.

Two years ago, the composition of the Chinese forum was predominantly Sino-Russian; this year's AirShow China may be referred to as Sino-Russo-Ukrainian, since all other countries were represented only nominally.

Russia, a traditional participant of the Chinese show, has always used these exhibitions to demonstrate the entire potential of its defence industry aimed at development of military-technical cooperation with Asian countries.

Russian companies' interest in the Zhuhai show is easy to understand if we remember that for the past decade China has been one of the major importers of Russian aircraft. In addition, Moscow perceives the show as a fairly convenient site for further promotion of its products to markets of Southeast Asia and Asia-Pacific.

Yury Khozyainov, assistant chair of Russia's Committee for Military Technical Cooperation with Foreign States, headed the Russian delegation at AirShow China 2002. According to Mr. Khozyainov, over half a year since the last meeting of the intergovernmental Russo-Chinese commission the countries have signed "a number of essential documents for large-scale deliveries of military hardware to China".

The two countries have also intensified cooperation in the realm of civil aviation. At the Zhuhai show Russia and China signed a programme to cooperate in civil aviation covering the following four fields: aircraft, engines, instruments and avionics, and materials; Russia has to offer China ready-made products, technologies, and joint aircraft development projects. The programme was signed within the framework of an agreement concluded in April 2002 between Russian Aviation and Space Agency Rosaviakosmos and China's Committee for Defence Science, Technology, and Defence Industry. The parties have assigned workgroups to deal with aforesaid fields; these workgroups are charged with elaboration of over 70 programme clauses. The first contracts under the programme may be concluded already by the year-end.

AVPK Sukhoi brought to Zhuhai aircraft models only

MMPP Salut presented a very interesting display

In 2001 Beijing contracted Rosaviakosmos to deliver five Tu-204s, with an option for ten more. China is now considering Russia's offers of Il-96-300, Tu-214, Il-103, and Il-114 airliners. The parties have signed a contract on deliveries of upgraded Mi-17V-5 transport helicopters to China, with an option for a batch of Mi-171s currently being negotiated.

The Sukhoi Aviation Military Production Corporation (AVPK) brought to Zhuhai scale models of the Su-24MK front line bomber, Su-27SK fighter, Su-30MK and Su-35 multirole fighters, Su-32 strike fighter/bomber, and Su-39 ground attack airplane. The company also showcased samples of major airborne ordnance types and fire control systems installed on Sukhoi warplanes: R-27ER1, R-73E, and RVV-AE air-to-air missiles, Kh-59MK and Kh-59ME air-to-surface missiles, and the Sapsan-E optronic sighting system.

AirShow China was the first exhibition at which Sukhoi acted as an independent entity offering post-sale servicing of its warplanes,

including spares deliveries. Direct negotiations with customers will enable quicker conclusion of mutually beneficial maintenance contracts. Sukhoi plans to introduce a comprehensive integrated logistics support system comprising interactive electronic documentation and advanced information exchange means.

The company is also gaining foothold in civilian aircraft building. Sukhoi Director General Mikhail Pogosyan believes 50% of the company's production programme should be civilian aircraft. Sukhoi has joined efforts with Ilyushin and Boeing in developing a family of RRJ (Russian Regional Jet) passenger airplanes; the company's own programmes include the Su-80 cargo/passenger machine, the S-38L agricultural airplane, and the Su-29 and Su-31M aerobatic aircraft. The Su-49 tandem trainer, whose development programme is nearing completion, has won the Russian Defence Ministry's tender.

One of the most interesting Russian exhibits presented at AirShow China was the Su-30MK training simulator by Aerospace Equipment Corporation (AEC).

AEC, which controls 55 to 65% of Russia's aircraft instrumentation market, has well-grounded exporting ambitions. The corporation's products account for 15% to 20% of equipment in exported Su-30MKs and MiG-29s. AEC management intends to merge daughter plants and design bureaux to bring annual production turnover to $2 billion by 2006, against some $270 million in 2001. Up to 75% of the corporation's aircraft equipment export volume falls to China. Last year AEC opened a representation at the premises of the Beijing-based Aircraft Instrument Company for coordination of joint work.

Anatoly Zakharevich, Chairman of the Board, Aerospace Equipment Corp., presenting the Su-30MK simulator

The Russian Aviation Simulator Engineering Centre was founded in May 2002 as a corporation of the leading domestic aviation simulator developers and manufacturers. Apart from AEC, the Centre lists as its members 11 organisations from various Russian regions, including the St. Petersburg-based United Avionics Consortium JSC, Pirometr JSC, Electroavtomatica Experimental Design Bureau; Moscow-based Sukhoi Design Bureau, TsAGI Central Aerohydrodynamic Institute, State Research Institute of Aviation Systems (GosNIIAS), Aviation Simulators JSC, Constanta-Design JSC, NTTs SKORZ; and Penza-based NPP Era JSC and Simulation Design Bureau.

Kh-59MK air-to-surface missile at the AVPK Sukhoi stand

One of the factors that prompted simulator engineers to join efforts is the necessity to overhaul Russia's stock of aircraft simulators and migrate to new-generation systems. According to expert estimates, simulator training accounts for not more than 13% of the overall combat training time of Russian military pilots, against 70% for their European counterparts. If Russia entered the international market of aircraft simulators it might secure high revenues. With so many Russian-made airplanes already exported globally, specialists estimate the market capacity for corresponding training simulators at $5 billion; this market is now being contested by leading European, US, and Israeli companies.

The Aviation Simulator Engineering Centre demonstrated the Su-30MK simulator with the standard visualisation system projecting the pilot's view onto a large screen placed immediately before the cockpit. The Centre also brought along an absolutely new visualisation technology (whose particulars are not yet disclosed), which uses the canopy as the screen. So powerful is the effect of this technology that several minutes spent in the simulator's cockpit make you completely forget you're chair-ridden, with your hands starting instinctively to grasp air at each manoeuvre. No less impressive is the texture of underlying terrain, which is based on real maps. In addition, the new technology considerably reduces the simulator's dimensions.

The AEC stand also showcased the Osa radar with a phased array antenna developed by the Tikhomirov Research Institute of Instrument Engineering (NIIP) and produced by the Ryazan State Instrument-Making Plant. The radar will be completely ready in 1,5 to 2 years, with flight tests scheduled for the near future.

The Phazotron-NIIR Corporation demonstrated a wide range of aircraft radars, including the Zhuk-MSE, Kopyo-F, Kopyo-M, and Kopyo-A models. The Chinese Air Force intends to purchase 100 Zhuk radars for its F-8IIM fighters for the total of $120-150 million. Beijing is also interested in joint development of a phased array radar.

Another Russian avionics producer, UOMZ, signed several contracts and preliminary agreements in Zhuhai. The enterprise concluded a preliminary order for several millions of dollars to supply spare parts to its licensee, Laiyang Electronic Instruments Factory. During bilateral talks the Chinese party proposed preparation of a programme for military and civilian technical cooperation. The programme may be approved in the first quarter of 2003.

Russian Aircraft Corporation MiG came to China for the first time after a long period of absence from the country's market. Nearly a half century ago, it was MiG warplanes that pioneered the Soviet Union's large-scale arms export to China. After Russo-Chinese cooperation had resumed in the early 1990s, Sukhoi drove MiG out of the Chinese defence market. Now the corporation is back to restore its former positions. MiG presented the entire range of its produce at

New visualisation technology of the Su-30MK simulator

MiG Corp. came to China after a long period of absence from the country's market

the Zhuhai show. Its stand was visited by a Chinese delegation led by Li Andung, deputy Armament Department chair of China's People's Liberation Army (PLA). Vyacheslav Meleshko, assistant to MiG's Director General, says the Chinese military is interested in the MiG-AT trainer and the twin-seat MiG-29M2 multirole fighter. The Chinese delegation showed a special interest in technologies implemented in the MiG-AT, like the reprogrammable digital fly-by-wire flight control system.

Says Vladimir Frolov, assistant to MiG's Director General, "We are ready to (...) develop cooperation with China, to share our experience in development of prospective warplanes and trainers, aircraft modernisation, and joint production of modern airplanes such as the Tu-334."

The counter-terrorist operation in Afghanistan's high-altitude and desert areas highlighted the critical role of combat and transport rotorcraft. A sizeable part of Russia's exposition was taken up by export variants of Kamov and Mil machines such as the Ka-50 and Ka-60 combat helicopters, the Mi-17-1V multipurpose helicopter, the Mi-17PGE EW rotorcraft, and the Mi-35, Mi-35M, and Mi-35P attack/transport helicopters.

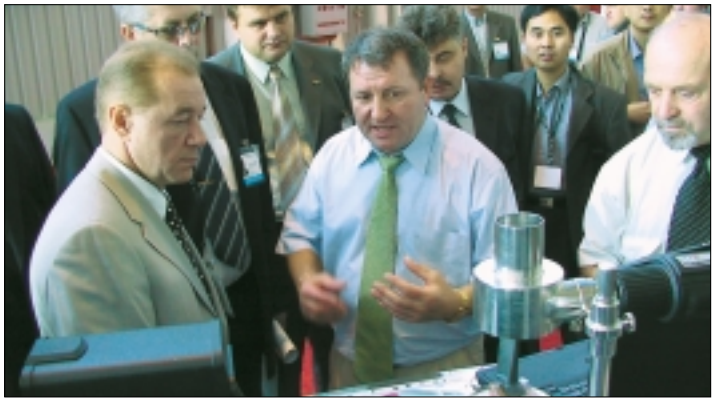
Company Automatic Systems Design presented its laser countermeasures station designed to protect fixed-wing aircraft and helicopters against heat-seeking missiles such as the Stinger, Strela, and Igla MANPADS. The station offers much greater efficiency than any existing Russian or foreign analogue, and at a much lower price.

MMPP Salut demonstrated a very interesting display featuring the AL-31FN afterburning turbofan engine with a fully-variable swivel nozzle and a bottom-mounted accessory box. These engines may be installed on Chinese J-10 fighters. Under a license agreement, China will repair engines locally.

Beijing will receive 54 AL-31FNs in the next two years. As the Chinese Air Force intends to purchase around 300 J-10s within one decade from now, China's long-term demand for Salut's engines may amount to several hundred pieces.

As was mentioned earlier, Ukraine was widely represented at AirShow China: around 20 Ukrainian businesses exhibited their products in Zhuhai, namely Antonov ANTK, KSAMC, InterAMI Corporation, Motor Sich JSC, Ivchenko Progress Design Bureau State Enterprise, Lugansk Aircraft Repair Factory, Navigator state enterprise, Ukrspetsexport state company, Arsenal Central Design Bureau, etc. Ukrainian aircraft builders were the only exhibitors to demonstrate flyable airplanes, namely the An-140 and the An-74TK-300. The machines had covered 20,635km in 54 hours to get to Zhuhai, a record of sorts for this class of aircraft.

The super-long flight gave the manufacturer an opportunity of testing the new aircraft in the Middle Eastern and Southeast Asian environment. According to KSAMC Director General Pavel Naumenko, the airplanes performed well in strange climes.



Yury Yeliseyev, Director General, MMPP Salut, (in the centre) shows Maj Gen Dmitry Morozov, RusAF Deputy Commander for acquisition (left), achievements of his company

Antonov used the air show to sign an agreement with China Aviation Industry Corporation I (AVIC I) on joint development of a supercritical wing for the prospective ARJ 21 regional jet currently developed by AVIC I Commercial Aircraft Co. Ltd. Ukrainian specialists will optimise the wing's aerodynamics, build and wind-tunnel wing models, and work out technical recommendations for the Chinese party.

Another agreement secured by Antonov in Zhuhai was a contract with Shaanxi Aircraft Industry Group on joint development of the Y-8F-600 aircraft based on the Soviet-era An-12 turboprop. Antonov specialists will take part in work of the aircraft's design, aerodynamics, structure, and endurance. Antonov will also wind-tunnel aerodynamic models of the Y-8F-600 at its facility.

During the Zhuhai air show, Ukraine and China initialled an agreement on cooperation in aircraft building for the next decade. The agreement grants China access to Ukraine's fundamental research materials and envisions training of Chinese specialists in Ukraine. Also during AirShow China, Beijing confirmed its request for two new An-74TK-300 transports. The aircraft may be delivered already in 2003, after which China intends to purchase a third machine of this type.

Other prospective fields of Ukraino-Chinese cooperation include upgrading of China's Y-5 aircraft (an analogue of the Soviet An-2 biplane), establishment of a servicing centre for An-12s and Y-8s in China, and joint maintenance of China's fleet of An-12s and Y-8s. Ukraine may also offer new An-140 passenger airplanes to Chinese carriers.

According to a forecast published by Boeing, in the next 20 years China will purchase 1,912 new passenger aircraft, to turn into the second largest aircraft market after the US. China is expected to spend $165 billion on new airplanes between 2001 and 2021. AVIC I predicts China's annual passenger traffic to be growing by 8.2% per year to reach 530 billion seat-kilometres by 2021, a figure five times as large as the current traffic level in China and sufficiently greater than the global mean rates. Yet higher traffic growth rates are predicted for China's airlift industry. Already today China airlifts 1.3 million tonnes of cargo per year domestically, ranking the world's second nation after the US in this category. With the volume and frequency of air cargo transportation expected to increase by 11.8% every year, China's annual airlift

turnover may reach 41 billion ton-kilometres in 20 years from now.

China's booming civil aviation market together with ever-increasing demands of the national air force have necessitated deployment of large-scale aircraft construction. Zhuhai's largest exposition belonged to Chinese enterprises, including the two major aircraft companies AVIC I and AVIC II (Aviation Industry Corporation I and II). The former is mainly engaged in construction of warplanes, while the latter majors in making transport aircraft and helicopters. The two corporations have equal capacities.

Unfortunately, the planned demonstration of the J-10, China's newest fighter, was cancelled. Instead, Chinese developers demonstrated full-scale mock-ups of the FTC-2000 trainer and the FC-1 light fighter. The FTC-2000, a brainchild of AVIC I's branch National Guizhou Aviation Industry Group (GAIC), had never before been demonstrated as a full-scale mock-up. The aircraft will take off for its first flight in late 2003, with the flight test programme scheduled for accomplishment in 2005.

The FTC-2000, a development of the FT-7 trainer (a two-seat variant of the Soviet MiG-21), is meant for the training of F-7 and F-8 fighter pilots. The aircraft may also be used in reconnaissance, EW, and anti-ground missions. It differs from its predecessors, the FT-7, FT-7A, and FT-7P trainer fighters, in a redesigned forward fuselage, now offering a better view from either of the two cockpits. With two jet intakes positioned on either side of the fuselage, designers freed the nose to accommodate a radar, whose antenna's diameter was in previous models restricted to the diameter of the jet intake cone.

KSAMC Director General Pavel Naumenko presents the An-140

The FC-1 (Super 7) lightweight multirole fighter is being designed with export prospects in mind. The multinational project team comprises Chengdu Aircraft Corporation (AVIC I) and Pakistan Aeronautical Complex, with participation of MiG specialists. The demonstrator's first flight is scheduled for late 2002, and Chengdu Aircraft Corporation plans launch production of the fighter in 2004; the company has already signed a protocol of intent with Pakistan's Air Force for deliveries of 150 FC-1s.

Ukraine may offer the An-140 to Chinese carriers

AVIC I's brochure positions the FC-1 as a new generation multirole lightweight fighter combining high performance with low cost. Enhanced aerodynamic parameters and a high thrust-to-weight ratio are expected to render the fighter supermanoeuvrable.

The FC-1 is powered by one RD-93 afterburning turbofan, which differs from the baseline RD-33 engine in that it has a bottom-mounted accessory box. The prototype of this engine was developed by the St. Petersburg-based Klimov Plant jointly with the Chernyshev Moscow Machine-Building Enterprise. China has already taken 12 such engines and mounted six of them on its FC-1s.

Chengdu Aircraft Corporation (AVIC I) continues to refine the F-7 fighter family (a development of the Soviet MiG-21). The plan to fit the aircraft with a more efficient radar moved the company to develop the F-7MF variant with low jet intake and canard surfaces. The F-7MF demonstrator is powered by the Kunlun I engine, and production fighters may be powered by the Kunlun II turbojet developed by AVIC I in cooperation with Shenyang Engine Design Institute. The Kunlun II was also demonstrated in Zhuhai.

AVIC II brought to the air show its Y-8X military airlifter project, yet another aircraft in the family of China's variations on the Soviet An-12 turboprop. Shanxi Aircraft Group works on the project jointly with Antonov. AVIC II demonstrated a scale model in the Chinese Air Force camouflage. The Y-8X is designed to carry 30t of payload to a range of 2,500km, or 17t to a range of 6,500km. The aircraft will be powered by four 6,500hp turboprops, possibly a development of the WJ-6 engine installed on the Y-8F-400 airlifter (the Y-8F-400 was issued an airworthiness certificate during the Zhuhai show).

China estimates the domestic demand for regional jets seating 60 to 90 passengers to be some 350 machines, with another 90 aircraft of this type required for cargo operations and charter flights. These figures considered, Commercial Aircraft Co. Ltd (AVIC I's branch) announced a year ago the programme to develop the ARJ 21 regional aircraft. A full-scale mock-up of this airplane was presented at AirShow China.

The 70-seat ARJ 21 might be marketed to Chinese carriers and exported to third countries. The completion of the preliminary engineering programme is expected in mid-2003. The first ARJ 21 may enter service in 2007; at least 300 aircraft are planned to be sold within the next 20 years. The basic ARJ 21 configuration may be developed into stretched and shortened versions for 90 and 60 seats, respectively.

Space research took up much of China's national exposition in Zhuhai. Beijing is readying its Shenzhou craft for the nation's first manned space flight. The Long March booster is already set for the ride; a fourth unmanned launch of the Shenzhou capsule is scheduled for the year-end. Chinese astronauts (or, as some in China suggest calling them, "taikonauts", "Taikong" being the Chinese word for "Space") currently undergo a training programme at a facility near Shanghai. Beijing also cherishes an ambitious dream of placing its own space station in orbit.

The Zhuhai exhibition demonstrated that China's aerospace industry is developing at a very fast pace. A balanced state policy and hefty investments have helped the country build the mightiest army and Air Force in the region. Beijing owes much of this military progress to cooperation with Russia and Ukraine, which has recently intensified to the benefit of both the customer and the contractors.

Andrei YURGENSON,
Valery AGEYEV

Model of the Y-8X military airlifter

GULF DEBUT

IRAN'S FIRST INTERNATIONAL AIR SHOW MARKED BY COOPERATION WITH UKRAINE AND RUSSIA

With the annual list of aerospace exhibitions cram-full as it is, start-up events rarely make headlines. The year 2002 was a pleasant exception however, as Iran staged its first International air show on 30 October through 3 November. The show was held on Kish Island, a free trade zone in the Persian Gulf separated from the mainland Iran by a strait 18km wide. The event was jointly organised by Kish Free Zone Organisation and the Civil Aviation Organisation of Islamic Republic of Iran (CAO-IRI).

Measuring some 90 square kilometres in area, Kish Island lies about 1,000km to the south east of Iran's capital Tehran, and only 170km to the north west of Dubai, one of the centres of the United Arab Emirates. Geographic proximity to the UAE largely influences economic life of the island, which operates 90 regular monthly flights to Dubai (two to five services per day).

The central part of the island is occupied by a first-rate airport with a 3+ km runway, built under Shah Reza Pahlavi specially to accommodate a supersonic Concorde that the Shah intended to purchase as a personal jet. The airport's advantageous location near the Strait of Hormuz can make it a critical military asset in the unquiet region.

The air show organisers, however, used every opportunity to emphasise the peaceful character of the event, whose official message was "To wish peace and friendship to all nations and security for all critical regions of the world".

Iran's first-ever air show was attended by around 70 exhibitors from 13 countries, including France, Germany, the UK, the Netherlands, Italy, Switzerland, the Czech Republic, Slovakia, Pakistan, Indonesia, Russia, and Ukraine. Ukrainian businesses predominated the static display and the pavilion, so a visitor might think at times that he was attending an extension of the Kiev Aviasvit show. Ukraine's ubiquity is accounted for by developing Ukraino-Iranian strategic partnership in aircraft building, which is based on the programme for licensed production of the An-140 regional turboprop dubbed IrAn-140 Faraaz ("Flying above the skies" in Persian). Two An-140s that were demonstrated in the static display site and performed during flight displays were the first locally-assembled IrAn-140 and one of the three production aircraft built by Kharkov State Aircraft Manufacturing Company (KSAMC); the latter airplane is operated by the Kharkov-based carrier Aeromist and wears a very attractive colour scheme.

Hojjat-ul-Islam Karrubi, the honorable speaker of Iran's Islamic Consultative Assembly (Parliament), welcomes the opening of the air show

Iran Aircraft Manufacturing Co. (HESA) is developing IrAn-140 production at its Shahin-Shahr facility near Isfahan. HESA rolled out a second Iranian-assembled airplane in late December 2002, with six more aircraft currently standing in the company's shops in various stages of completion. The initial production plan envisioned assembly of 24 machines in the first quarter of 2004; the entire $193 million contract covers construction of 80 aircraft by the second quarter of 2009, with possible output extension to as many as 105 aircraft.

Reality might beat these ambitious plans: according to unofficial sources, not more than six to eight Iranian-assembled aircraft will enter service in 2003. The designed production capacity of the Shahin-Shahr assembly line is 12 aircraft per

Title photo: the first HESA-built IrAn-140

year. In the initial stage, the assembly costs will be shared in the following manner: 30% for HESA and 70% for the KSAMC and its contractors; this ratio is to reverse by the end of the contract term. Iran will pay for assembly packages of units and components, and also for services of Ukrainian engineers; overall payments will amount to $9.5 million per each aircraft, whereas ready-made aircraft would have cost Tehran $15-16 million apiece.

IrAn-140 assembly is a matter of national pride in Iran, which has been suffering from US-imposed economic sanctions and trade embargo since the 1979 Islamic Revolution. HESA's Shahin-Shahr assembly facility was visited by Iranian President Mohammad Khatami and the Supreme Leader Ayatollah Seyed Ali Khamenei. Ayatollah Khamenei thus referred to the IrAn-140 programme in his speech before HESA employees: "This remarkable feat, which has its roots in steel of your determination, proved you do have the ability to secure a resounding success in this field (aircraft manufacturing). You proved you match up with the rest of the world when it comes to production of aircraft. Now blaze a trail and take the industry to uncharted terrain. I am sure you can, because you have proved you can. I am fond of and believe in what you do here. I follow the developments here on a regular basis and I am satisfied with the results."

Mi-171 manufactured by Ulan-Ude plant was the only Russian aircraft present at the show

Press-conference on Ukraino-Iranian joint programme IrAn-140. Left to right: Pavel Naumenko, KSAMC Director General, Mohammad Eslami, Iran Aircraft Industires (HESA) managing director, Yaroslav Goloborodko, Antonov deputy Director General

It may be unusual for a state leader to go poetic when speaking of domestic aircraft building, but the joint project with Ukraine is really the much-needed shot in the arm for Iran's hi-tech industry. About 250 Iranian specialists have taken training courses in Kharkov, and ten Iranian universities have opened aircraft engineering departments. And even though KSAMC Director General Pavel Naumenko stresses that the licensing agreement is entirely civilian in character, the fact that Iranian military experts finalised the contract's details leaves no doubts about its importance to Iran's defensive capacity.

Vice Admiral Ali Shamkhani, Minister of Defence and Armed Forces Logistics, stated unambiguously in his interview to "Iran International" that "Iran's Defence Ministry struck partnership with Ukraine to secure a number of objectives, among them production of aircraft... Aircraft manufacturing, the missile industry and air defence have many things in common. Progress in one field means the ministry can use its achievements in the other two".

The IrAn-140's commercial benefits for civilian operators are not readily perceivable: with Iran's air transport market strictly controlled by the state, and with artificially restrained flight fares covering only 30–50% of carriers' operational costs, domestic operators cannot survive without state subsidies – or without large-scale market reforms. In this situation HESA pins its passenger IrAn-140 hopes on a state leasing programme that would help with the aircraft's service entry, although the particulars of this programme (if any) remain unknown.

In general, however, the uncertain fate of the IrAn-140's passenger variant does not jeopardize the programme on the whole. HESA's design bureau, which employs about 500 qualified specialists, presented at the air show models of two military An-140 modifications, the IrAn-140T tactical airlifter and the IrAn-140MP maritime patrol aircraft.

The IrAn-140T retains the baseline airplane's wing and empennage, but has a lift-down cargo ramp fitted in the aft fuselage. The aircraft features reinforced landing gear and Ukrainian-built AI-30 engines, which offer 20% more power than those powering the baseline model. The tactical airlifter is designed to carry 50 troops, or two jeeps, or two howitzers, or five standard LD3 pallets, or 18 stretcher casualties. The aircraft may also be used in cargo/troop airdrop missions. With 1,350m of required runway length, the IrAn-140T's maximum load amounts to 5,500kg; the machine has a range of around 2,900km with 4,000kg payload.

The IrAn-140MP modification is meant for maritime patrolling and anti-surface and anti-submarine operations. Five possible onboard equipment configurations are currently under consideration. In the maximum configuration (HMS-500) the onboard equipment will include additional navigation systems, a search radar, a thermal imaging system, an electronic reconnaissance system, a digital data link, sonobuoys, a magnetic anomaly detector, and up to four operator's workstations.

The aircraft will be redesigned to house new systems; observation blisters and a tail magnetic anomaly detector boom will be installed, and the output of power supply and air conditioning systems increased. No information was available at the air show as to the aircraft's weaponry capability. Other planned IrAn-140 modifications include a VIP variant and an AWACS aircraft with a rotating radar dome fitted above the fuselage.

Vice Admiral Ali Shamkhani thus determined the priorities of Iran's defence programme: "Top

on tne agenda of Iran's defence program are unmanned aerial vehicles (UAVs), tactical and trainer aircraft, ballistic and cruise missiles." That UAVs were mentioned first reflects the contemporary tendency for wider use of remote-controlled aircraft in the battlefield. Apart from several lightweight piston-engined UAVs, the HESA design bureau currently develops the Ababil jet UAV designed for aerial target drone, tactical reconnaissance, and EW missions. However, a warhead could be easily installed as well, thus turning the vehicle into a cruise missile. The Ababil is expected to have a cruising speed of between 600 and 800km/h, cruising altitude of 500 to 10,500m, maximum flight endurance of one hour, and maximum range of 850km.

The UAV is planned to be powered by one 377kg thrust Tolooe-4 turbojet weighing 55 kg. According to Iranian sources SAHA company based in Tehran has recently launched production of this engine. A 2002 contract envisions deliveries of a more advanced engine modification, the Tolooe-5. The Tolooe was apparently developed outside Iran, but we could not find anybody willing to acknowledge responsibility for the design, and Iranian "stepfathers" decline to comment on the technology's origin. The Ababil is designed for jet-assisted takeoff from a truck-mounted mobile launcher with adjustable elevation angle. The UAV's landing will be assisted by a parachute and an airbag-type inflatable shock absorber. An aerodynamic model is thought currently to be tested in a wind tunnell, with HESA engineers developing design documentation.

The air show featured a Tazarve jet trainer demonstrator being developed by the Aircraft Industries Organisation on contract from the Iranian Defence Ministry. The Aircraft Industries Organisation may best be defined as a state committee for aircraft industry directing the activities of state-run aircraft building companies, including the three largest ones: HESA, SAHA, and PANHA. Although Tazarve developers do not comment, for secrecy reasons, on their affiliation with any particular company, nor do they disclose the location of the development facility, certain indirect signs point to Tehran.

The Tazarve programme is called "Project Ya Hossein", with the aircraft designated JT2-2, i.e. the second modification of the second trainer type. The first indigenous trainer, the JT1 Dorna developed in the early 1990s, had poor pilot handling qualities. The second trainer type, the Tondar, which completed its first flight in 1998, proved much better and was later used as the basis for the Tazarve's development. The new trainer's piloting characteristics meet the standards of Iranian military, which finances a programme to build five demonstrators and 25 production aircraft.

The testing programme for the second Tazarve demonstrator is expected to start in 2003, with series production scheduled for launch in 2005. The aircraft has a maximum takeoff weight of 4,000kg, a maximum speed of 648km/h, and is powered by one J85-GE-17 turbojet engine with 1,300kg thrust. This engine type has been around since the early 60s and will remain in operation until the 2040s; General Electric claims around 6,000 such engines power aircraft in 35 countries. Tehran purchased a batch of J85-GE-17s from the US in the 1970s to install them on F-5 fighters; Iran still keeps at least 20 such engines, unpacked, at storage facilities – that must be quite enough to power the first batch of Tazarv trainers.

Zaporozhye engine manufacturers confirm off the record that Iran is interested in purchasing Ukrainian-built engines for its Tazarves, although things haven't yet gone further than initial consultations.

The Tazarve's major feature is an all-composite airframe built with use of carbon-carbon and fibreglass materials. Technologically speaking, the airframe consists of three major parts: the fuselage, the wing, and the tail unit. The wing is attached to the fuselage with use of four bolt joints. The demonstrator's composite surfaces were manually lined, but an automated lining technology will be introduced by the launch of series production. The trainer's airframe has a service life of 6,000 flight hours.

The Tazarve's two cockpits are fitted with traditional instruments, partially taken from stocks of pre-embargo supplies and partially indigenously-built. The VHF radio is Iranian-made, as are certain onboard systems, the canopy, and the landing gear legs and wheels.

Every day of the air show the Tazarve demonstrator participated in display flights, showing fairly good aerobatic capabilities. All preflight preparations and postflight checks were devoid of unnecessary fidgety, with minimum servicing personnel involved – an indication that the aircraft is easy to maintain even at airfields outside the home base. The Tazarve convincingly exemplifies the extraordinary capacities of Iran's aircraft industry.

Ukrainian aircraft dominated the static and flying displays. Left to right: IrAn-140, An-74TK-300, 2nd production An-140

Another such convincing example is the RF-5 fighter reequipped by HESA into a twin-seat trainer. Two of these aircraft were demonstrated in the static display at the air show. The production date markings on Martin Baker ejection seats installed in the aircraft's cockpits read 1992 and 1993 – just another proof that Iran knows how to bypass the US embargo on imports of critical components.

Malek Ashtar University's Tehran-based research centre is working on a new generation combat aircraft, the Shafagh. According to unofficial reports, Russian specialists participate in the project. This subsonic strike aircraft has a designed empty weight of about 5,000kg, a wingspan of 12m, and a length of 14m. The Shafagh was demonstrated at the air show in the form of models in Iranian Air Force camouflage, a wind tunnel model, and photos of a full-size mockup in a hangar. The first demonstrator is scheduled for rollout only in 2008.

Iranian indigenous trainer JT2-2 Tazarve has an all-composite airframe

Iran is developing an advanced subsonic Shafagh attack aircraft

As for rotorcraft building, Iran demonstrates impressive capabilities in both maintaining its fleet of US-built helicopters and retro-engineering American rotorcraft into indigenous modifications. HESA demonstrated at the air show its HHH combat helicopter based on the Bell 209 HueyCobra, and PANHA (IHSRC, Iran Helicopter Support and Renewal Company) presented the Shabaviz and Shahed 276 rotorcraft developed from the Bell 205 Iroquois and Bell 206 JetRanger, respectively.

The only Russian-made aircraft presented at the air show was the Mi-171 built by Ulan-Ude Aviation Plant (Ulan-Ude, Buryatia). Apart from 25 such helicopters purchased directly from the manufacturer over the past several years, Iran operates several second-hand Mi-171s acquired from somewhere in post-Soviet states. The plant agreed to extend its post-sale servicing programme to these "prodigal children", and sent maintenance teams to Iran to prolong the Mi-171s' life for another 1,500 flight hours. It was one of the renovated Mi-171s that took part in flight displays at the Iran air show. The Ulan-Ude Aviation Plant's stand was deployed next to that of Kazan Helicopters, which offers Tehran modified Mi-17s and its new Ansat rotorcraft. So far, however, Buryatian helicopter manufacturers lead the competition for Iran's helicopter market.

Another Russian exhibitor at the Iran air show was Aviazapchast PLC. The enterprise cherishes hopes for contracts to supply IrAn-140 spare parts, claiming the share of Russian-made components in this aircraft is as high as 70%. Despite this, all spare deliveries are currently managed by a Ukraino-Iranian joint production directorate founded by HESA and KSAMC, and chances are slim that this situation will change.

Shafagh full-scale mockup in a hangar near Teheran. The prototype's roll-out is scheduled for 2008

Apart from the two An-140s, visitors of the air show saw a Kharkov-built An-74TK-300, an An-74T-200 of the Iranian Air Force test centre, and even an An-124 Ruslan heavy airlifter, whose only mission was to once again demonstrate Ukraine's achievements in aircraft building.

Ukraine's hold on Iran is firm and well-calculated, but Russian counterparts aren't forgotten. Pavel Naumenko, KSAMC general director, said at a press conference held jointly with Antonov ANTK and HESA management that the IrAn-140 programme is being developed by three countries: Ukraine, Iran, and Russia.

Due to understandable political reasons, the Iranian market must be of very high priority to Russian industry, however, judging from Russian participation in the Iran air show, there is little if anything at all to enforce this statement. Russian Aircraft Corporation MiG's widely-advertised programme to launch licensed production of Tu-334 passenger airliners in Iran, though once positioned by the MiG management as the corporation's ticket to diversification into civilian aircraft building, has by now ceased to exist, which was noted indirectly and diplomatically, but nevertheless clearly at the news conference by HESA Director General Mohammad Eslami.

In general, the Iran air show's debut was an indisputable success of the organisers, who welcomed exhibitors and visitors with highest-level Oriental hospitality. The show will now become regular, with the next event planned to be held in the autumn of 2004, also on Kish Island. To venture a large-scale international air show in a politically unstable region required much determination, even courage. It will be justified to give the air show organisers their due and state that they have succeeded in demonstrating the achievements and high potential of Iran's aircraft industry. As a side effect, they have attracted global attention to Kish Island as a developing tourist centre of the Persian Gulf.

Alexander VELOVICH

MiG OPERATIONAL FLYING TRAINING SYLLABUS

How Indian Air Force pilots learn to fly MiG fighters

The state of Assam in North East India is blessed with extremes of weather. During the monsoon from April to September it has held records as the wettest place on earth, however during the winter months, clear pollution free skies are the norm. The Indian Air Force flying training syllabus originates in the trouble free areas of the south and progresses to Eastern Air Command for the advanced Stage 3. The Northern States are surrounded by Bhutan and China to the North and East, and Myanmar and Bangladesh to the South.

After graduation from the Airforce Academy the students are sent to Air Force Station Barrackpore, near Calcutta for their TETRA course. Here future aircrews and ground crews get to learn about the MiG-21. They spend 78 hours spread over 85 periods learning the general description of the aircraft, including 24 periods on the airframe and 24 on the engine, and after the 5-week course they have to take an exam. Those that pass go onto the MiG Operational Flying Training (MOFT) Syllabus and are despatched to the airfields that cater for it in the various commands. This usually amounts to about 45 students going to the main airfields in Eastern Air Command (which we will describe below) and approximately 30 students going to the 15th, 32nd and 101st squadrons in the west. The latter three squadrons operate MiG-21bis and MiG-21M aircraft, and because of the height limitations in the MiG-21FL, pilots with a torso or sitting height of over 98.25 cm will come here.

Until 31 October 2002, five units flying the MiG-21FL and MiG-21UM would take the students for Semester 1 of the MOFT Syllabus in Eastern Air Command. They were the MiG Operational Flying Training Unit and the 30th Sqn at Tezpur, the Operational Conversion Unit and the 52nd Sqn at Chabua and 8th Sqn at Bagdogra. However, the 30th Sqn was number-plated on 31 October 2002, after 33 years of continuos service with the MiG-21FL.

For the first two weeks the students study the pilots notes on the aircraft and the airfield standing operating procedures. At the end they have to achieve a 95% pass rate in the exam and if they fail, they get one more chance to take it. They then progress onto the simulator where they complete several sorties to increse their knowledge of the type. The initial flying phase lasts for 30 weeks and will include 30 flying training sorties and 48 fighter sorties. Initially the students will complete about nine sorties, dual in the MiG-21U before being allowed to go solo. During dual training they practice low speed handling and must complete one practice diversion. Regimes covered include circuit training, aerobatics, loose formation flying, medium tactical flying, 2 and 4 ship formations, low level tactical flying with two aircraft and four aircraft, instrument flying.

Semester 2 commences after six months and continues with more advanced flying. The basic principals of ground attack, air combat training, advanced air combat and live firing are taught to the flying officers. 28 sorties are completed in the MiG-21U trainer and a further 70 are completed on the MiG-21FL. During the live firing phase, sorties are flown to the Dolungmurgh Range, 125 km northeast of Tezpur. This range is shared with Chabua and Mohanbari, and the aircraft adhere to strict slot times over the target. Weather over the range and at diversion airfields has to be clear before a sortie can depart. Normal weapons carried are the GSh-23 cannon loaded with 60 rounds, two UB-16 rocket pods each with one 57mm rocket projectile and 25lb practice bombs. Upon completion of Semester 2 the students would have flown a grand total of 58 trainer sorties and 118 fighter sorties, amounting to 105-110 flying hours. They are then deemed daytime operational on the MiG-21.

During the course of the syllabus, their instructors assess the pilots and gradually their personal file is built up. Upon completion of the MOFT Syllabus they are posted out to MiG-21, MiG-23, MiG-27 and Jaguar squadrons, depending on their abilities. During their first operational tour they learn to become night operational.

Weather plays an important part in the MOFT syllabus. Although semesters usually start on 1 January and 1 July, bad weather and operational deployments of the frontline squadrons involved with the syllabus can delay the beginning and the end of courses. Some courses spend the majority of their flying during the bad weather months from April onwards, but the chances are that they would have graduated from a good weather course whilst undergoing Stage 2 or 2A at the Air Force Academy.

Occasionally, different permutations are tried during the MOFT syllabus. For example, currently at Chabua, the OCU were training Semester 1 pilots only, whilst Semester 2 was handled by the 52nd Sqn. Also, some pilots from Semester 1 at the OCU had been sent to the 8th Sqn at Bagdogra to complete Semester 2, as they have more airspace at their disposal, Chabua being very close to Myanmar and China.

MiG Operational Flying Training Unit

MiG Operational Flying Training Unit (MOFTU) was formed on 15 December 1986 at Tezpur to impart Stage 3 training on the MiG-21FL and MiG-21U. The primary role of the unit is to instruct operational flying training to pilots inducted into the fighter stream. MOFTU is the largest fighter-flying establishment in the Indian Air Force, consisting of two squadrons, Alpha and Bravo. The unit has stood up twice for operational deployments in time of tension with Pakistan, the first being Operation Brass Tacks in January 1987 and more recently Operation Parakram in May 2002. Each time they despatched aircraft to operate at bases in Western Air Command, where they stood alert on operational readiness platforms. Experienced pilots were also despatched to other units to augment their aircrew strength. The unit emblem depicts a Hawk (signifying an instructor), leading a fledgling (symbolising a student).

moved to their current location of Tezpur in 1973. The unit has won numerous awards during its life and has actively participated in the training of Stage 3 pilots. An average of 15 students at any point in time, being the norm. Due to the shortage of airframes, the squadron became the first in the run down of MiG-21FL squadrons to be number-plated. This occurred on 31 October 2002, exactly 33 years to the date on formation. On that day the station stopped to watch the fly-by performed by the remaining seven pilots. Its assets were then distributed amongst other squadrons. The unit emblem depicts a one horned grey rhino, commonly found in this part of India and signifying strength and courage.

52nd Sqn, 'The Sharks'

The 52nd Sqn is the youngest fighter squadron in the Indian Air Force and was raised at Hashimara on 1 January 1986. The squadron moved to Bagdogra during January 1990 and then moved to its current location of Chabua on 1 November 1996. The primary role of the squadron is air defence and the secondary is ground attack. However during peacetime the squadron is given the additional responsibility of conducting the MOFT Syllabus of young pilots. Like the other operational squadrons, the 52nd one was also forward deployed to the west during times of tension in 1987 and again this year. The squadron badge is a shark signifying the aggressive nature of fighter pilots and the ability to work as part of a team. It also symbolises the ability to foray close to the shores to strike blood and terror.

Phillip CAMP & Simon WATSON
(Wingman Aviation)

30th Sqn, 'The Rhinos'

The Rhinos Sqn was formed on 1 November 1969 at Tezpur with MiG-21FLs. During the 1971 war with Pakistan, they maintained deployments at Kalaikunda and Panagarh in the east and during the first day on 4 September they were dog fighting against Pakistani F-86s over Dacca. A week later the squadron was split in two and despatched to Panthankot and Chandigarh in the western sector. They maintained aircraft at operational readiness alert and engaged the enemy on numerous occasions, but without success. After the war they returned to the east and were stationed at Kalaikunda from where they

SPACECRAFT LAUNCHES THE RUSSIAN FEDERATION PERFORMED OR CONTRIBUTED TO IN 2002

Launch No	Space vehicle No	Space vehicle	Date of launch	Cosmodrome	Launch vehicle designation	Space vehicle mission
1*	1	Kosmos-2387 (Kobalt)	25 February	Plesetsk (launch site 43)	Soyuz-U (11A511U)	In the interests of the Russian Ministry of Defence
2*	2 3	GRACE-1 (Tom) GRACE-2 (Jerry)	17 March	Plesetsk (launch site 133)	Rokot+ Briz-KM Booster Unit (BU)	Study of the Earth gravitational field – determination of its parameters and their changes, connected with tectonic processes, movements of ice, water and atmospheric air (moisture)
3*	4	Kolibri-2000 (Kolibri-1, Mikrosputnik-1)	20 March	Board of the Progress M1-7 space vehicle	-	Study of the magnetosphere and Van Allen radiation belt of the Earth depending on solar activity, effects of man-caused processes in near-Earth space environment above Europe and Australia
4*	5	Progress M1-8 (11F615A55)	21 March	Baikonur (launch site 1)	Soyuz-U (11A511U)	Delivery of consumables and various payloads to the International Space Station (ISS)
5*	6	Intelsat-9	30 March	Baikonur (launch site 81)	Proton-K (8K82K) with DM-3 BU	Support of a direct television broadcasting, voice communications and data transfer through the Internet in the countries of North and South America, Europe, the Middle East and Africa
6*	7	Kosmos-2388 (Oko)	2 April	Plesetsk (launch site 16)	Molniya-M (8K78M)	In the interests of the Russian Ministry of Defence
7*	8	Soyuz TM-34 (11F732)	25 April	Baikonur (launch site 1)	Soyuz-U (11A511U)	Replacement of the Soyuz TM-33 spacecraft (Crew Rescue Vehicle (CRV)) in the ISS structure, fulfilment of technological researches and experiments under the Russian program and the Marko Polo program of the Italian Space Agency, accomplishment of the flight according to the "space tourist" contract. Crew – Yu. Gidzenko (Russia), R. Vittorio (Italy, European Space Agency (ESA)), M. Shuttleworth (South Africa)
8*	9	DirecTV-5	7 May	Baikonur (launch site 81)	Proton-K (8K82K) with DM-3 BU	Support of radio- and TV-broadcasting over CONUS and Hawaii
9	10	Kosmos-2389 (Parus)	28 May	Plesetsk (launch site 132)	Kosmos-3M (11K65M)	In the interests of the Russian Ministry of Defence
10*	11	Express-A3(A1R)	10 June	Baikonur (launch site 200)	Proton-K (8K82K) with DM-2M BU	Support of radio- and TV-broadcasting, voice communications, broadcasting of federal radio and TV programmes in a digital mode over central regions of Russia, in CIS countries, Europe, the Middle East and North Africa
11*	12	Galaxy-IIIC	16 June	Odysseus marine floating platform (Pacific Ocean, latitude 0°, longitude 154° west)	Zenit-3SL	Support of radio- and TV-broadcasting, data transmission, including in the Internet in the USA and Latin America
12*	13 14	Iridium (SV97) Iridium (SV98)	20 June	Plesetsk (launch site 133)	Rokot+ Briz-KM BU	Iridium Satellite Communications System. Support of telephone, facsimile and personal mobile communications, position finding of the system users
13*	15	Progress M-46 (11F615A55)	26 June	Baikonur (launch site 1)	Soyuz-U (11A511U)	Delivery of consumables and various payloads to the International Space Station (ISS)
14*	16 17	Kosmos-2390 (Strela-3) Kosmos-2391 (Strela-3)	8 July	Plesetsk (launch site 132)	Kosmos-3M (11K65M)	In the interests of the Russian Ministry of Defence
15*	18	Kosmos-2392 (Arkon, Araks)	25 July	Baikonur (launch site 81)	Proton-K (8K82K) with DM-5 BU	In the interests of the Russian Ministry of Defence, Earth remote sensing, ecological monitoring, detection of sites of fire, support of fishery
16*	19	EchoStar-8	22 August	Baikonur (launch site 81)	Proton-K (8K82K) with DM-3 BU	Support of direct television broadcasting in the digital mode over CONUS, Alaska, Hawaii, Tahiti, Puerto Rico
17*	20	Progress M1-9 (11F615A55)	25 September	Baikonur (launch site 1)	Soyuz-FG (11A511U-FG)	Delivery of consumables and various payloads to the International Space Station (ISS)
18*	21	Nadezhda-M (17F118M)	26 September	Plesetsk (launch site 132)	Kosmos-3M (11K65M)	Functioning in the structure of the International Space SAR System for ships and aircraft in distress (KOSPAS-SARSAT), position finding of mobile overland and marine objects, accumulation and transmission of meteorological, oceanographic and ecological information
19*	22	Integral	17 October	Baikonur (launch site 200)	Proton-K (8K82K) with DM-2 BU	Observation and study of X-rays and gamma-radiations of space objects
20*	23	Soyuz TMA-1	30 October	Baikonur (launch site 1)	Soyuz-FG (11A511U-FG)	Replacement of the Soyuz TM-34 spacecraft (Crew Rescue Vehicle (CRV)) in the ISS structure, fulfilment of technological researches and experiments under the European Space Agency (ESA) and Russian programmes (Odyssey project). Crew – S. Zaletin (Russia), F. de Vinn (Belgium, European Space Agency (ESA)), Yu. Lonchakov (Russia)
21*	24	Astra-1K	26 November	Baikonur (launch site 21)	Proton-K (8K82K) with DM-3 BU	Support of television broadcasting and Internet - communication in European countries
22*	25 26	Mozhayets Alsat-1	28 November	Plesetsk (launch site 132)	Kosmos-3M (11K65M)	Ham radio. It is used to train specialists in space trades, improve space navigation systems handling technique Monitoring of the environment in order to provide warning of natural phenomena, disasters and catastrophes.
23*	27 28 29 30 31 32	UNISat-2 Saudi-Sat-1S Latin-Sat-A Latin-Sat-B Rubin-2 2001-Trail Blazer	20 December	Baikonur	Dnepr	Realisation of scientific researches Communication satellite Communication satellite Communication satellite Communication satellite Development of bulky objects' injection into orbit
24*	33	Kosmos – 2393 (Oko)	24 December	Plesetsk	Molniya-M (8K87M)	In the interests of the Russian Ministry of Defence
25*	34-36	Kosmos-2394, 2395, 2396 (Uragan)	25 December	Baikonur	Proton-K (8K82K) with DM-2 BU	Functioning in the structure of the GLONASS Global Space Navigational System
26*	37	Nimid-2	30 December	Baikonur	Proton-K (8K82K) with Briz-M BU	Support of direct television broadcasting over Canada and CONUS

Additional information

1* Space vehicles and the LV are designed by the «TsSKB - Progress» Central Specialised Design Bureau State Research and Production Rocket Space Centre (Samara).

2* Commercial launch. The LV is developed on the basis of the RS-18 (SS-19) ICBM, phased out pursuant to START I Treaty. Modernisation of the LV and development of the Booster Unit (BU) are carried out by the Khrunichev State Space Research and Production Centre (Moscow) on order from Rosaviakosmos. The GRACE space vehicle (GRACE-Gravity Recovery and Climate Experiment) – is the joint project of NASA (USA) and DLR (German Aerospace Centre). The space vehicles are developed by the Astrium company (Germany) with participation of Space Systems/Loral company (USA). Under the project, management and systems' development are carried out by Jet Propulsion Laboratory (USA). Space vehicles are absolutely identical to one another.

3* The launch is devoted to the 40th anniversary of flights into the space of Yuri Gagarin and German Titov and to the 100th anniversary of independence of Australia (1901). Initiators of development of the space vehicle together with schoolboys from Russia were schoolboys from Sydney (Australia). This is the first school space vehicle in Russia. It was developed under the international program Mikrosputnik on the non-commercial and non-governmental basis without engaging budgetary funds, great volume of activities was executed on public principles, activities were paid by the Russian and Australian parties. The space vehicle was designed and manufactured in the Special Design Bureau of Space Engineering (Tarusa) and the Institute of Space Investigations (IKI) of the Russian Academy of Sciences. A number of systems were developed by the Rosaviakosmos enterprises and the NILAKT ROSTO enterprise. The parent enterprises of the project "Kolibri-2000" from the Russian party are the Institute of Space Investigations and the Korolev Rocket and Space Corporation Energia (Korolev, Moscow Region). The flight control of space vehicle was executed from the ground-based complex, located in Kaluga, stand-by station – in Tarusa. The space vehicle's onboard computer had a recorded voice of Konstantin Tsiolkovsky, his great-grandsons, schoolboys - participants of activities from Obninsk and Sydney, music. Signals from the space vehicle were received by radio amateurs, its radio beacon had an index – RS-21. The Kolibri space vehicle was launched into the space from the Progress M1-7 spacecraft after its undocking from the ISS. The space vehicle accomplished its in-orbit flight on 4 May 2002, having made 711 revolutions around of the Earth.

4 *, 13 *, 17* The space vehicle was designed by the Korolev Rocket and Space Corporation Energia.

5* Commercial launch. The LV was designed by the Khrunichev State Space Research and Production Centre (parent organisation responsible for the launch from the Russian Federation). Enterprise responsible for Booster Unit was the Korolev Rocket and Space Corporation Energia. The launch was carried out by ILS company (International Launch Services), founded by the Khrunichev Centre, Energia and Lockheed Martin Space Systems corporation (USA). The space vehicle belongs to the International Satellite Communications Company (Intelsat Ltd.). It was manufactured by Space Systems/Loral company (USA).

6*, 24* The space vehicle was designed by the Lavochkin Research and Production Association (Khimki, Moscow Region) on the order of Rosaviakosmos.

7* The space vehicle was designed by the Korolev Rocket and Space Corporation. Shuttleworth's space flight was carried out pursuant to the commercial agreement between him and Rosaviakosmos. M.Shuttleworth became the second space "tourist" who personally paid consumptions, connected with his flight. During the flight M.Shuttleworth executed a programme of researches.

8* Commercial launch. The Khrunichev Centre was a parent organisation responsible for launch from the Russian party. The space vehicle belongs to DirecTV Inc. (USA); it was manufactured at the Space Systems/Loral company's plant. The launch was serviced by the ILS company.

9* The LV was manufactured by the Polyot Production Association (Omsk) on the order of Rosaviakosmos.

10* The space vehicle was developed by the Reshetnev Research and Production Association of Applied Mechanics (Krasnoyarsk) on the order of Rosaviakosmos while on-board equipment was designed by the Alcatel Space Industries company (France). The customer and the owner of the space vehicle is the Space Communications Federal State Unitary Enterprise of the Russian Ministry of Communications which is also Russia's national satellite communications operator. The space vehicle is the last in the Express-A batch of space vehicles. The Booster Unit was developed by Energia.

11* The space vehicle belongs to the PanAmSat company (USA). It was designed by Boeing Satellite Systems (USA). The commercial launch was carried out under the Sea Launch project with participation of Russia, Ukraine, the USA and Norway. Parent organization responsible for the launch from the Russian party was the Korolev Rocket and Space Corporation Energia. The LV consists of the following stages: the Zenith-2S LV, developed and produced by the Yuzhnoe Design Bureau named after Yangel and the Yuzhny Machine-building Plant (Ukraine, Dnepropetrovsk) and the DM-SL Booster Unit, developed by Energia and used as the 3rd stage of the LV.

12 * Commercial launch. The space vehicles were designed and belong to Iridium Satellite LLC company (USA) and produced by Lockheed Martin (USA). The parent organization responsible for the launch from the Russian party was the Khrunichev State Space Research and Production Centre. The launch was serviced by joint European-Russian enterprise Eurockot Launch Service GmbH.

14 * The space vehicle was designed by the Reshetnev Research and Production Association of Applied Mechanics (Krasnoyarsk), the LV – by the Polyot Production Association (Omsk).

15 * The space vehicle was designed by the Lavochkin Research and Production Association. The space vehicle is equipped with the largest space telescope in Russia by now (diameter of the mirror is 1.6m). The snapshots will be used in the interests of the Russian Ministry of Defence and for sale abroad.

16* The commercial launch was carried out by Russian-American company ILS. The space vehicle was designed by Space Systems/Loral (USA). The parent organisation responsible for the launch from the Russian party was the Khrunichev State Space Research and Production Centre.

18 * The space vehicle was designed by the Polyot Production Association (Omsk) (onboard service systems) and Research Institute of Space Engineering (Moscow) on the order of Rosaviakosmos (search-and-rescue radio system). The space vehicle is the last (the 10th) vehicle of the system, developed on the basis of the Tsikada navigational space vehicle.

19 * Commercial launch. The European Space Agency (ESA) was responsible for designing the Integral space vehicle (International Gamma Ray Astrophysics Laboratory). The space vehicle proper was produced by the Alenia Aerospazio company (Italy). The experimental equipment was designed in the countries which are the members of the European Space Agency (ESA). The parent organisation responsible for the launch from the Russian party was the Khrunichev Centre, the scientific supervisor of the project from the Russian party was academician R.Syunyaev (Institute of Space Investigations (IKI) of the Russian Academy of Sciences).

20 * The space vehicle is the first in a new series of spacecraft, designed by the Korolev Rocket and Space Corporation Energia.

21* The Booster Unit was designed by the Korolev Rocket and Space Corporation Energia, and was manufactured by the Voronezh Mechanical Plant. Due to off-nominal functioning of the booster unit the space vehicle wasn't launched into the calculated orbit. On 10 December by a command from the Control Centre in Zurich, Switzerland the space vehicle was de-orbited and was sunk in the Pacific Ocean. The space vehicle belonged to the SES company. France, Sweden and many other EU countries participated in the designing of the vehicle, while Alcatel Space (France) produced the space vehicle.

22 * Alsat was a commercial launch. Alsat, Algeria's first space vehicle, was designed by the SSTL company (Surrey Satellite Technologies Ltd, UK) with participation of National Centre of Space Engineering (Algeria) that paid consumptions for the launch. This launch is the beginning of creation of the international system of the Earth space monitoring DMC (Disaster Monitoring Constellation). Algeria, China, Nigeria, Thailand, Turkey, the UK are the participants of this project.

The Mozhaets space vehicle was designed by the Reshetnev Research and Production Association of Applied Mechanics (Krasnoyarsk) with participation of the Mozhaisky Military-Space Academy (St. Petersburg). The LV is manufactured by the Polyot Production Association (Omsk).

23 * The LV is developed under the conversion program on the basis of the phased out RS-20 (SS-18) ICBM. The conversion programme is being implemented by the International Space Company Kosmotras under the 1991 START I Treaty between the USSR and the USA. Kosmotras includes enterprises of the space-rocket branches of Russia and Ukraine. The launch was a silo one. The UNISat-2 space vehicle was developed at the request of the Rome University (Italy). The Saudi-Sat-1S space vehicle was designed by the Institute of Space Investigations of Saudi Arabia. The Latin-Sat-A and Latin-Sat-B space vehicles were designed by the Space Quest company (USA) and belong to Argentina. The Rubin-2 space vehicle was designed by the OHB-System company (Germany). The space vehicle 2001-Trail Blazer was designed by Ukrainian enterprises at the request of the USA and is a weight-dimension mock-up of the space vehicle intended for flight to the Moon.

25* The space vehicle is designed by the Reshetnev NPO PM Research and Production Association of Applied Mechanics (Krasnoyarsk), manufactured by the Polyot Production Association. The LV is designed by the Khrunichev State Space Research and Production Centre, the Booster Unit – by the Korolev Rocket and Space Corporation Energia

26* Commercial launch. The space vehicle belongs to Canada. The LV and the Booster Unit were designed by the Khrunichev State Space Research and Production Centre. Nimid is the Eskimo for tie together, connect.

Remarks

1. On 21 February, the Echo Star VII space vehicle (USA) was launched from the Cape Canaveral cosmodrome (USA) by the Atlas-3B LV (USA). On 22 August, the Hot Bird space vehicle (USA) was launched by the Atlas-5 LV (the first launch). The first stages of both LVs have the RD-180 dual-chamber oxygen - kerosene engine, designed by the Glushko Energomash Research and Production Association (Khimki, Moscow Region), on the order of Rosaviakosmos. The first launch of the US LV equipped with the RD-180 engine, designed in Russia, took place in 2000. The contract on manufacturing the RD-180 engine was concluded between NPO "Energomash" and Lockheed Martin Space Systems corporation.

2. On 12 July the Demonstrator-2 space vehicle with an inflatable descent system was launched along a ballistic trajectory by the Volna conversion ballistic missile. The launch was made from the Project 667BDR Kalmar class Ryazan SSBN of the Northern fleet deployed in the Barents Sea. The calculated place of touchdown of the space vehicle was the Kura target range (Kamchatka Peninsula), in-flight time – 30 min. Nevertheless, the space vehicle wasn't detected in the calculated place of touchdown. The space vehicle was designed by the Babakin Research Centre (Khimki, Moscow Region), which is a part of the Lavochkin Research and Production Association, with participation of the Astrium company (Germany). The Volna BM was designed by the Makeyev Rocket Centre Design Bureau (Miass) on the order of Rosaviakosmos on the basis of the RSM-50 combat marine ballistic missiles. Participants of the IRDT Inflatable Re-entry and Descent Technology program are the following enterprises: the Babakin Research Centre, the Lavochkin Research and Production Association, the Makeyev Design Bureau, the European Space Agency (ESA), and the Astrium company, which financed the project. The inflatable descent structure has a scientific equipment.

3. In 2002, 25 launches of space vehicles from cosmodromes, the floating platform and the Progress spacecraft were made in the Russian Federation or with its participation. A total of 37 space vehicles were injected into the Earth orbits (except the space vehicle in article 1 of remarks), of these 19 space vehicles belong to Russia. As many as 24 LVs were used for their launching, them being Soyuz – 6, Proton – 9, Kosmos – 4, Zenit – 1, Rokot – 2, Molniya – 2, Dnepr – 1. A total of 16 launches were conducted from the Baikonur cosmodrome (23 space vehicles were orbited), the Plesetsk cosmodrome saw 8 launches (13 space vehicles), the marine floating platform – 1 (1), the Progress spacecraft – 1 (1).

The material was submitted by Rosaviakosmos

FLYING RADARS

From the history of Russian Airborne Early Warning and Control Systems

For decades aerial intruders into hostile airspace would fly low and use earth terrain to avoid detection by air defence surveillance radars most efficiently. The obvious solution for the air defence was to place a watchdog radar as high as possible, and even better to mount it on an airborne platform. This concept gave birth to airborne early warning systems (AEW), in which the Soviet Union tried hard to keep pace with the West.

Liana or Tu-126

In 1958 the OKB-156 design bureau, headed by Andrey Tupolev, was tasked with development of an airborne early warning platform, designed for a reliable radar protection of northern and north-eastern Soviet borders, which had no conventional ground systems. An aircraft like that, designated Tu-126, was to be developed jointly with the new Tu-28-80 (Tu-128) long-range all-weather interceptor within the framework of the National Air Defence modernisation programme. Both projects were launched into development by the decree of the USSR Council of Ministers dated 4 July 1958. Radar equipment to be fitted on the AEW aircraft was to be designed by NII-17 Scientific Research Institute (now the MNIIP Moscow Research Institute of Instrument Engineering), as well as OKB-373, NII-25, and NII-101. The OKB-156 design bureau was appointed flagship designer of the system proper.

By late 1958 the customer had provided OKB-156 with specification requirements to be met by the system, and the design bureau started to work on the draft design. In compliance with the decree, the Tu-95 bomber, and its high-altitude version, Tu-96, as well as the Tu-116 transport, based on the Tu-95, which featured quite a large cargo hold, were initially considered as platforms. The Ozero radar was one of the options for the air and maritime surveillance radar system.

However, tests, conducted by the design bureau's technical projects department, headed by Sergey Yeger, proved that the AEW aircraft should be based on the Tu-114 passenger airliner, the Tu-95 fuselage dimensions being unable to either accommodate the radar system and facilitate its normal operation, or allow for an efficient work of its operators.

It took the design bureau two years to complete the scientific development stage. This fact was caused by several reasons: first and foremost, the brass kept on insisting on using the mass produced Tu-95 as a platform, rather than the unfamiliar civilian Tu-114, which had yet to pass official tests. Development of radar equipment and its accommodation on the aircraft also faced certain challenges. In a way, Soviet aircraft experts had to design the Tu-126 platform from the scratch.

Finally, in early 1960 things began to look up: the Tu-114 underwent official tests, and the real Liana radar, the backbone of the future AEW platform's radar system, had come into being. As a result, on 30 January 1960 the final design of the new Tu-126 version, based on the Tu-114, was adopted, launching the design stage proper. Nikolay Bazenkov supervised the development. The lion's share of the development, aimed at converting the Tu-114 into the Tu-126, was borne by OKB-156's affiliate office at plant No 18 (Kuybyshev, now Samara), headed by Alexander Putilov.

The most considerable modifications were introduced to the Tu-114 fuselage and the special equipment suite, while the pilot's and the navigator's cockpits, most assemblies and aircraft system were practically left intact. The upper deck behind the pilot's cockpit now housed the radar operators' cockpit, divided into compartments. The first compartment quartered the aircraft computer, the operators' workstations, and some of the Liana radar's

units. The starboard accommodated the navigator's seat, three workstations of tactical operators, and one workstation of the technical operator, while the port side housed the Liana radar's units and the guidance officer's workstation. Unlike the Tu-114, the Tu-126 enabled the crew to bail out of the aircraft via a special emergency hatch in the first fuselage compartment, and via the nosewheel well in case of emergency. Just like the Tu-114, the new platform featured the antenna of RBP-4 Rubin panoramic radar under the nose.

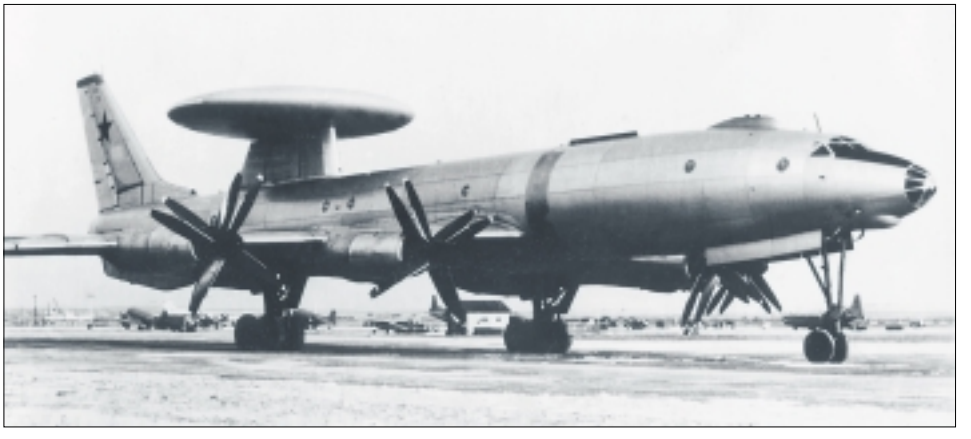
The fist compartment was followed by the coat closet, and then by the second compartment (at the preliminary design stage it was reserved for auxiliary equipment). The third compartment housed the gunner, who operated the remotely controlled tail gun mount.

The fourth compartment was designed as a rest room for the crew. The fifth compartment was fitted with the Liana radar units, while the sixth one quartered the Kristall data transmission system. The Liana radome was mounted on a powerful pylon over the fifth compartment. An additional ventral fin was mounted under aft fuselage to provide the aircraft with sufficient stability and controllability. Special vortex generators, which increased the efficiency of the aircraft controls, were mounted on both sides of the mid radome pylon. Special attention was paid to providing easy access to the system's units. The radome and the pylon boasted special hatches for radar installation and inspection.

The Tu-126's innovations included the Liana radar radome, rotating with the aerial. The following two options were proposed: a fixed radome on a pylon, with the aerial rotating inside; and a rotating radome integral with the aerial. Thorough investigation resulted in selecting the second option as a lighter and an easier one. The partially radar-transparent radome with a diameter of 11 metres rotated at a speed of 10 rpm. Alexander Putilov was the one to suggest that a rotating radome should be fitted on the aircraft. At first, Tupolev was against his proposal, given the fact that back then the USSR did not produce such huge bearings. It was only after quite a heated debate, that Tupolev himself became an ardent advocate of the idea and, using his tremendous authority, persuaded the government to issue a decree on the bearing for the Tu-126. As a result, the Tu-126 became the world's first AEW aircraft with a rotating mushroom-shaped radome.

The Tu-126's lower fuselage deck housed some of the equipment of various aircraft systems and the electronic countermeasures suite (ECM). Cowlings of the liquid- and air-cooled radiators, which maintained a normal temperature of the equipment, were mounted under the fifth compartment.

The aft fuselage was to be fitted with a gun mount with two AM-23 cannons, the Kripton radar sight, and a TV-guidance sight. The tailplane fairing accommodated the Arfa matching antenna of the Kristall system.



Tupolev Tu-126 became the first AEW aircraft in the Soviet Armed Forces inventory

In the course of further development designers rejected the tail gun mount, thus making the gunner redundant. The layout of the radar system's operators was also slightly changed, while fairing of the celestial sextants was mounted over the first compartment. Besides, the aircraft was fitted with the anti-radiation system, designed to protect the crew from radiation, emitted by the radar system, etc.

Preliminary calculations proved that the Tu-126 was capable of cruising for 11 hours, detecting B-52 aircraft at a range of 300km to 400km, and cruisers at 400km. The communications suite was capable of transmitting data to an air defence command post at a range of up to 2,000km. Yeger's department looked into the feasibility of the aircraft's combat employment in every detail.

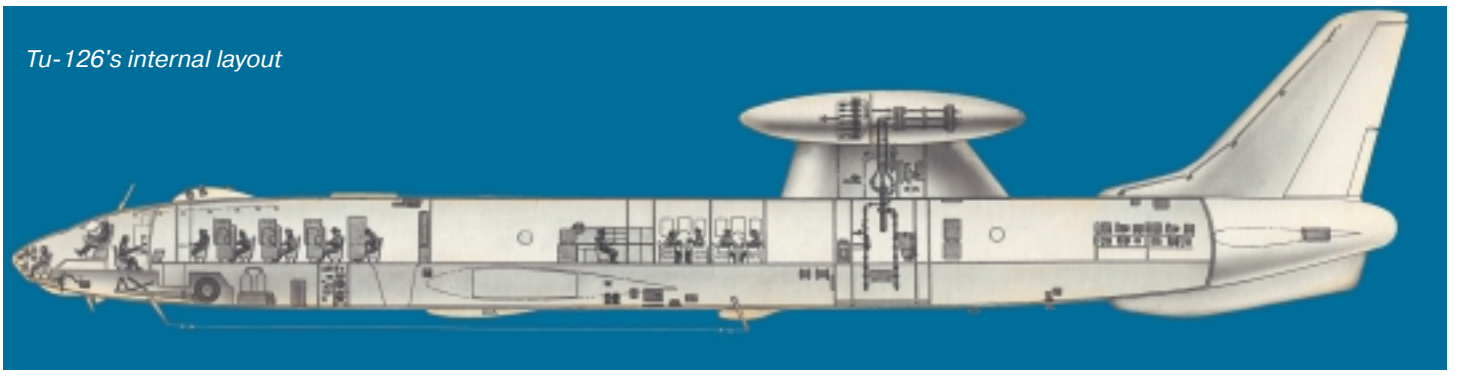
Air attack systems featured great air speeds, which left little time to put air defence systems on high alert. Thus, it was of paramount importance to project the detection range as far away from the border as possible, and set up this radar range perimeter in any direction in under three hours. The Tu-126's mobility provided excellent manoeuvrability both in depth and direction; furthermore, the necessary build-up of forces could be carried out in any direction on short notice (for instance, it took only ten hours to fly the aircraft from the Kola Peninsula to Vladivostok. Unlike early warning ships, the Tu-126 could be employed in areas, where weather conditions prevented maritime early warning systems from being deployed at a specified time.

The Tu-126 was reported to have high immunity to anti-radiation missiles. Its radar system was capable of detecting such missiles, their platforms, and operating radars long before the aircraft approached the edge of the stand-off zone. In addition to that passive air defence systems were thrown off the Tu-126's scent due to specific operational mode of the aircraft's radar system. Active operation of the Liana radar alternated with radio silence, when only on-board passive radar reconnaissance systems remained operational. Within three minutes of radio silence the Tu-126 flew 30 to 35km away, which was enough to disrupt the lock-on of enemy missiles.

The Tu-126 was capable of successfully reconnoitring CVBGs (aircraft carrier battle groups), its high air speed enabling it to outrace hostile naval fighters.

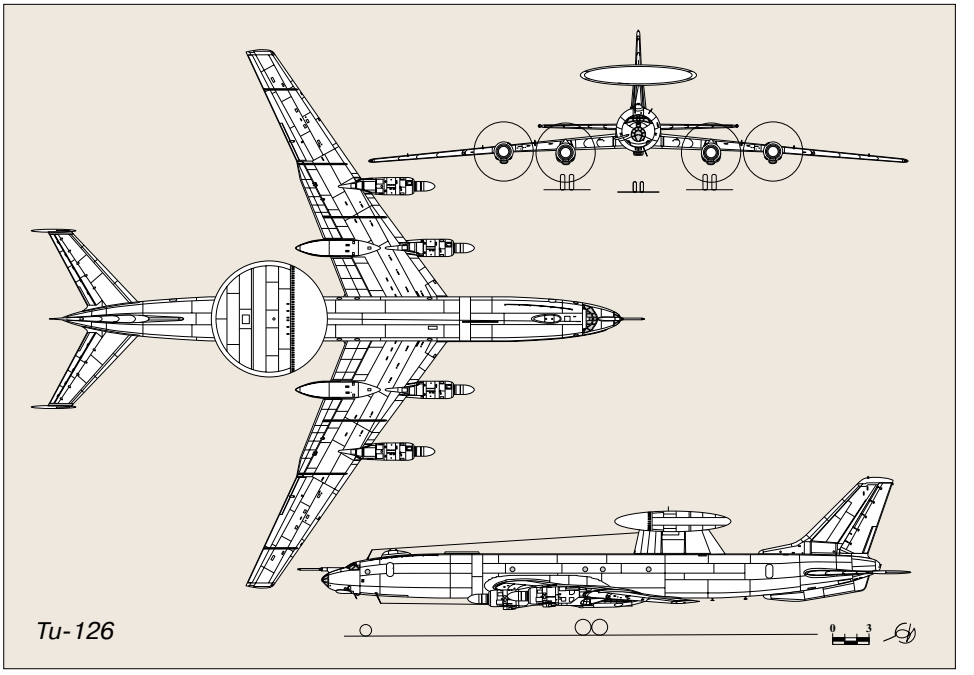
When investigating the platform's combat employment, the military looked into the feasibility of joint missions with long-range interceptors. Joint operations of the Tu-126 and the Tu-128

Tu-126's internal layout



long-range interceptors turned out to be capable of setting the interception range of targets, flying at a speed of 900km/h (B-52, B-47 bombers, Vulcan, Valiant, and Victor), at 1,000 km from the coastal line. Given cooperation like that, a guidance officer was included into the Tu-126's crew, although the initial Air Force specification requirements did not envision the Tu-126 to be employed like that.

Following two years of meticulous development of all issues, pertaining to the Tu-126, which resulted in leaving only its designation intact, the process evolved into building the first Tu-126 prototype. In 1960 the USSR Council of Ministers issued the second decree, concerning the Tu-126, which stated: "Kuybyshev aircraft plant No 18 is hereby ordered to produce one Tu-126 aircraft with the Liana radar system, a set of aircraft assemblies for bench tests, and three Liana radomes in compliance with production forms and documentation, developed by OKB-156 and NII-17... OKB-156 is to hand over Tu-126 production forms and documentation to aircraft plant No 18 in June-August 1960. NII-17 is to hand over the Liana radar production forms and documentation to aircraft plant No 18 by 5 June 1960. Plant No 18 is to deliver the following products to OKB-156: a Tu-126 aircraft for flight tests by August 1961; a set of aircraft assemblies for bench tests by the fourth quarter of 1960. Plant No 18 is to deliver three radomes to plant No 23 in July 1960 in order to install the Liana aerial. The State committee on radio electronics is ordered to deliver one Liana radar system to plant No 18 in January 1961 to be mounted on the Tu-126 platform. Following the joint tests, the Tu-126 is to be transferred to the Ministry of Defence. The Council of Ministers of the Russian Soviet Federative Socialist Republic and the Moscow Soviet of People's Economy are hereby ordered to have plant No 23 manufacture three sets of aerials: one for bench tests at OKB-156 in September 1960; one for tests and refinement at NII-17 in October 1960; and one to be mounted on the Tu-126 in November 1960. The Tu-126 is to undergo joint flight tests in the fourth quarter of 1961..."


Tu-126

Tu-126 primary specifications

Engine type	4xNK-12MV
Engine power, hp	4x15,000
Aircraft length (with refuelling probe and SPS-100 jammer), m	58.0
Wing span, m	51.4
Aircraft height, m	15.3
Max take-off weight, kg	171,000
Max speed at 9,000 m, km/h	790
Cruise speed, km/h	650-700
Service ceiling, m	10,700
Service range, km:	
w/o in-flight refuelling	7,000
with in-flight refuelling	10,000
Endurance, hrs:	
unrefuelled	10.2
refuelled	18
Run, m	2,400
Roll, m	1,200
Crew:	
flying	6
mission	6

Liana radar performance

Upper hemisphere air target detection range, km:	
fighter-type	100
bomber-type	200-300
Lower hemisphere cruiser detection range from 2,000-5,000 m, km	400
Data transfer range, km	up to 2,000
Simultaneously tracked targets	14

The Tu-126 mock-up commission convened the meeting on 7-12 December 1960, while as early as autumn 1961 the first Tu-126 (serial number 68601 or 61M601) was built and submitted for joint tests. On 23 January 1962 the crew, headed by test pilot Ivan Sukhomlin and consisting of co-pilot Lipko, navigators Rudnev and Iksanov, and flight engineer Dralin, took the prototype for its maiden flight. The first seven test flights were carried out with a mock-up of the Liana radar system, while later on the aircraft was fitted with the radar and its units at a Lukhovitsy facility outside Moscow. The first round of joint tests was completed on 8 February 1964.

The Liana radar system and the integral compatibility of the radar equipment were the primary objects of the first stage of the tests. The second stage of the tests, which was completed in November 1964, was aimed at testing interoperability of the Tu-126 with ground- and sea-based command posts, reliability of data transfer, as well as conducting joint operations with air defence systems. All these tests saw participation of the first aircraft No 601.

The Tu-126 differed but slightly from the Tu-114 insofar its performance was concerned. Despite the fact that the aircraft was fitted with relatively large additional vertical and horizontal airfoils, stability and controllability were the same as that of the prototype. The aircraft achieved a maximum air speed of 805km/h at an altitude of 10,500m, at the same time it experienced slight buffeting, which did not have any impact on its piloting characteristics. The take-off speed totalled 270-290km/h, while the landing speed equalled 250-270km/h.

The first Tu-126 was demonstrated to the Soviet top brass twice and received positive assessments.

In November 1963 with the tests still under way, it was decided to launch the aircraft into series production at plant No 18. In 1965-67 the plant manufactured eight production Tu-126s (two aircraft in 1965, another three in 1966, and the last three in 1967). Series-produced aircraft were fitted with the air-refuelling system. Three aircraft (No 63M611, 66M613, and 66M622) were delivered without the aft-mounted ECM system (the jammer). Instead, the tail unit housed only chaff dispensers. Aircraft No 65M612 and 67M622 boasted a new elongated tail unit, which quartered the SPS-100 Rezeda ECM system and chaff dispensers, and in this light the aircraft were fitted with a smaller ventral fin.

In April 1965 the Tu-126 was fielded with the National Air Defence. In 1966 first series production Tu-126s started to enter service with the 67 separate AEW squadron, at first deployed in the Kola Peninsula, but later transferred to an airfield outside Siauliai (Lithuania), which received all Tu-126s, including the first prototype, as they were gradually accepted by the customer. Operating jointly with interceptors, Tu-126 aircraft had provided excellent security to northern Soviet borders for 15 years, until 1984, when they were replaced by A-50 airborne early warning and control system (AEW&C) aircraft, equipped with the Shmel radar system.

From Liana to Shmel. The Tu-156 project

The Tu-126 AEW aircraft, fitted with the Liana radar system, had risen to the challenge of countering enemy air targets, until NATO attack aircraft started to operate at low and extremely low altitudes. The main drawback of the Liana system consisted in its inability to detect targets, flying at low altitudes, against the terrain background. Special training courses, undertaken by Tu-126 crews, allowed pilots to decrease the aircraft's operational altitude, from which it was capable of illuminating targets by its radar from beneath. However, this was only an intermediate solution to the problem, and Air Defence forces needed a new AEW system, which would be capable of detecting aircraft both from below and from above.

That is why as early as the late 1960s the USSR started to develop a new AEW system, fitted with the Shmel (Bumblebee) radar system. The latter was to be capable of detecting high-speed low-flying targets at a range of 200km, when carrying out surveillance in the lower hemisphere, and at a range of up to 500-600km, when conducting surveillance in the upper hemisphere, as well as processing data on the targets detected. The government adopted a decree on the Shmel radar system in 1969. MNIIP Moscow Research Institute of Instrument Engineering, headed by chief designer Vladimir Ivanov, which had designed the Liana radar system, was appointed flagship developer.

In 1970 the Moscow-based Opyt (Experiment) Machine-building plant (that was the name plant No 156 and OKB-156 received in the mid-1960s) developed a draft design of the new AEW platform, designated Tu-156 (aircraft 156). The Tu-142M ASW aircraft, the Tu-154 passenger airliner, and the very same Tu-126 were considered as baseline aircraft for the Tu-156. However, the Tu-142M was rejected due to certain difficulties in accommodating the radar equipment, while the Tu-154 was turned down as it would have been a must to introduce drastic changes to its baseline design, and besides it featured a relatively small endurance. The Tu-126 was the most suitable option, but since its series production had already been terminated and its equipment dismantled, the choice of the Tu-126 was purely academic. Thus, in this particular case the analysis of the existing Tupolev aircraft, which could be considered potential platforms for the Shmel radar system, could only result in determining the starting point for developing a totally new aircraft.

This was the very approach, embraced by the design bureau later on: it developed a draft design of a totally new aircraft for the Shmel radar system with the same designation, Tu-156, which was a jet, powered by four D-30KP engines, which featured a layout similar to that of the US E-3A. However, the design bureau's proposal was rejected: the customer wanted the platform for the new system to be based on a series production aircraft. As a result the mass-produced Ilyushin Il-76 military transport was selected as the platform for the Shmel. The Taganrog Machine-building Plant (Naval Aircraft-Building Design Bureau), headed by chief designer Aleksey Konstantinov, after Georgy Beriev had retired, was tasked with converting the Ilyuhsin aircraft into AWACS. The AWACS aircraft with the Shmel radar system, based on the Il-76, was designated A-50.

Shmel from Taganrog. A-50

The decree of the Central Committee of the Soviet Union Communist Party and the USSR Council of Ministers of 1973 ordered the Taganrog Machine-building Plant (now – Beriev company), headed by chief designer Aleksey Konstantinov, to develop the A-50 AWACS aircraft, based on the Il-76M transport and fitted with the Shmel radar system. Deputy chief designer S.A.Atayants was tasked with direct supervision of the A-50 development.

Since the new A-50 aircraft featured unrivalled capabilities in the USSR, insofar its sophisticated avionics, powerful electric sources, liquid- and air-cooling systems were concerned, the design bureau's experts faced a host of technical challenges, which either had never been addressed before at all, or had been of a considerably smaller scale.

The fact that the aircraft was fitted with a great number of powerful transmitters and highly sensitive receivers, quartered next to one another, made it a must to solve the problem of electromagnetic compatibility, which was later on successfully resolved on a full-size mock-up.

In order to provide stable operation of avionics and high reliability of the system proper, given considerable heat release, designers developed unmatched air- and liquid-cooling systems, as well as automated systems, facilitating their operation.

A special electric power system, boasting high current characteristics, was designed to power the on-board radar system.

Considerable efforts were aimed at adjusting and fine-tuning the Shmel radar system. Its separate components were tested on the LL "A" flying testbed, manufactured by the Taganrog Machine-building Plant and based on the first Tu-126 prototype (No 68601). The flying testbed made its maiden flight in Taganrog on 15 August 1977 (with Vladimir Demyanovsky as the crew commander).

When developing the A-50, designers carried out considerable research and development to provide the platform, fitted with a large rotating

Primary specifications of the two Tu-156 project versions

Engine type	4xNK-12MV	4xD-30KP
Engine power (thrust), hp (kgf)	4x15,000	4x12,000
Aircraft length, m	58.0	52.5
Wing span, m	51.4	45.8
Wing area, sq. m	...	307
Aircraft height, m	...	14.6
Empty weight, kg	119,350	107,350
Max take-off weight, kg	185,000	182,000
Fuel capacity, kg	60,600	...
Cruise speed, km/h	700-720	720
Service ceiling, m	10,000	10,000
Service range, km:		
unrefuelled	6,600	5,200
refuelled	8,400	6,800
Endurance, hrs:		
unrefuelled	10	...
refuelled	16	...
Run, m	2,750	...
Roll, m	1,300	...
Crew	23*	9

* two shifts

LL "A" flying testbed was derived by Beriev company in 1977 from the Tu-126 No 601 for Shmel radar system tests

radome, with sufficient aerodynamic characteristics and stability. As a result, aerodynamic performance, stability, and controllability of the new aircraft turned out to be only slightly different to those of the baseline Il-76M aircraft. In order to increase the A-50's flight endurance, it was decided to fit the aircraft with an air-refuelling system.

The lion's share of modifications, introduced into the baseline military transport, when it was converted into the AWACS aircraft, was caused by the necessity to accommodate new avionics and other equipment, facilitating its operation.

In compliance with the new role of the aircraft, the aft cargo hatch and the portside door were welded up, while every piece of transportation rigging was stripped off. The tail gun mount was replaced by the electronic equipment compartment. The satellite communications aerial fairing was mounted right in front of the wing centre section.

The Shmel radar system was housed inside the fuselage, with the radar transmitter being quartered in its rear part. In order to protect the crew from microwave emissions, rear fuselage was separated from the rest of the aircraft by a screen, while windows were equipped with metal-coated glass. Radar aerial was fitted inside a rotating radome with a diameter of 10.2m and two metres thick. The air-intake of the equipment cooling system was housed in the tailplane root.

The Shmel radar system comprised the following components:

- a 3D Doppler pulse radar;
- data display equipment;
- an active interrogation-reply and command transmitting system;
- digital computer;
- IFF system;
- command and control equipment;
- communications equipment;
- datalink equipment, etc.

Operators' automated workstations were fitted with colour CRT displays, which displayed alphanumeric and panoramic data. They also displayed data on interceptors, cooperating with the AWACS aircraft.

The A-50 AWACS aircraft was operated by a 10-man strong mission crew, including chief operator (radar system commander), navigators, tracking operators, and flight engineers, and a five-man strong flying crew.

The Taganrog Machine-building Plant completed converting a series production Il-76M military transport, built by the Tashkent Aircraft Plant, into the first A-50 prototype in 1978, while on 19 December of the same year a flight crew, headed by Vladimir Demyanovsky, took it for its maiden flight. The first flights were conducted without the radar system. After the radar system had been installed, the A-50 was submitted for joint official tests.

From December 1978 until October 1983 the Beriev company converted a total of two series-produced Ilyushin Il-76Ms and one Il-76MD, which participated in the joint official tests. The first A-50 (aircraft A-1) was used to test flight characteristics and radar system support systems. The second prototype (A-2) tested the radar system proper and the new Punktir integrated flight and navigation system, while the third one (A-3), which became the pattern aircraft for series production A-50s, became the test bed for the ECM suite and special equipment.

The most crucial stage of the tests was held at the NII WS Soviet Air Force Scientific Research Institute in 1980-85 (now the Akhtubinsk-based GLITs Russian Air Force State Flight Test Centre named after Valery Chkalov).

In December 1984 the authorities arrived at a decision, based on the test results, to launch the A-50 AWACS aircraft into series production at the Tashkent Aircraft Plant (now the Tashkent Aircraft Production Corporation, TAPC). In 1985 A-50s started to enter service alongside Tu-126s. The A-50 AWACS aircraft, fitted with the Shmel radar system, was officially fielded in 1989. By that time 67th separate AEW squadron was reorganised into 144th separate AEW regiment.

Until 1990 A-50 aircraft had pulled routine duty, occasionally participating in large-scale training exercises of the Soviet Armed Forces and joint exercises with armed forces of the Warsaw Pact member-states. In the winter of 1991 as Operation Desert Storm unfolded in the Persian Gulf, a pair of A-50s, hovering over the Black Sea, tracked combat aircraft of the allied coalition, delivering air strikes on Iraq from the Turkish territory.

In late 1994 the A-50 went into harm's way during the anti-terrorist campaign in the North Caucasus. Three A-50 AWACS aircraft were transferred to the operational airfield in the North Caucasus. They provided uniform radar coverage of the battlefield by constantly being in the air. On 21 December 1994 Russian Air Defence forces established complete control over Chechnya's airspace after almost a three years' break. Joint patrol missions, flown by A-50s and Su-27 and MiG-31 interceptors, prevented Chechen terrorists from establishing an air route with foreign terrorist-harbouring nations. A-50 aircraft also discharged similar tasks during the anti-terrorism campaign in winter 1999-2000.

By the time the USSR broke up, the Tashkent Aircraft Plant had manufactured approximately two dozen production A-50s, fielded with the 144th separate AEW regiment, deployed at an airfield outside the Lithuanian town of Siauliai, and later on transferred to the Berezovka airfield near Pechora town in northern Russia, when the Baltic states declared their independence. At the pre-

Beriev A-50 AWACS prototype. About two dozen such aircraft were built in 1980s for Soviet Air Defence Forces and later inherited by the Russian Air Force

A-50 primary specifications	
Engine type	4xD-30KP
Thrust, kgf	4x12,000
Aircraft length, m	46.59
Wing span, m	50.5
Wing area, sq. m	300
Aircraft height, m	14.76
Empty weight, kg	119,000
Max take-off weight, kg	190,000
Fuel capacity, kg	64,820
Max speed, km/h	810
Cruise speed, km/h	750
Service ceiling, m	12,200
Patrolling altitude, m	8,000-10,000
Unrefuelled service range, km	5,100
Unrefuelled endurance, hrs	7.8
Patrolling endurance, hrs:	
1,000 km off-base	4
2,000 km off-base	1.4
Run, m	1,900
Roll, m	820
Crew:	
flying	5
mission	10

Shmel radar performance	
Fighter detection range, km:	
upper hemisphere	300-350
against earth background	220
Cruiser detection range	400
Simultaneously tracked targets	50
Simultaneously guided fighters	10
Weight, kg	22,000

sent time the regiment has been transformed into the AEW aircraft airbase, deployed since 1998 outside Ivanovo. Another 20 A-50 AWACS aircraft, fitted with the Shmel radar system, were to have been produced in Tashkent by the mid-1990s, and then the plant was to have shifted to manufacturing upgraded A-50Ms with improved Shmel-2 radars, but these plans had never been fulfilled due to the break up of the USSR and the economic recession in the post-Soviet Russia.

Shmel evolution. A-50M, A-50I, and A-50E

Given experience, acquired during the tests and the initial operation, deep modernisation of the A-50 AWACS aircraft and its radar system started as far back as the mid-1980s.

The decree of the Central Committee of the Soviet Union Communist Party and the USSR Council of Ministers dated 9 January 1984 ordered the Beriev company to develop an upgraded A-50M aircraft, fitted with the Shmel-2 radar and powered by the D-90 engines (now known as the PS-90A). The new radar system, being developed by MNIIP, the flagship enterprise of the Vega Scientific Production Association, was to provide a greater detection range and magnification of the targets tracked, as well as to feature a capability of guiding more fighters to the targets. In addition to the new radar system the platform proper, its integrated flight and navigation system, and ECM suite were also considerably improved.

The draft design of the new A-50M aircraft (product 2A) was developed as far back as 1984, and its mock-up was built the same year. In order to test the new radar, the new LL "2A" flying testbed, based on the LL "A" (Tu-126 No 68601), was built in 1987. The Tashkent Aircraft Production Corporation started to build the A-50M prototype, which was to undergo tests in 1989. The flight tests over, about three dozen production A-50Ms were planned to have been produced by the turn of the century.

However, as fate would have it, the plans had to be considerably revised. An economic crisis had become apparent by the late 1980s, and the development of the new radar system was no longer properly funded. As a result, the A-50M project, just like a number of other promising projects in the sphere of combat aviation, was terminated in compliance with the decree of the USSR Council of Ministers dated 22 October 1990. Production of the first A-50M in Tashkent was stopped, while the LL "2A" flying testbed was ferry-flown to the LII Flight Test Institute, where it had been stored on the outskirts of the airfield, until it was scrapped (participants in the first Mosaeroshow and MAKS air shows, held in the early 1990s, could easily see it standing there).

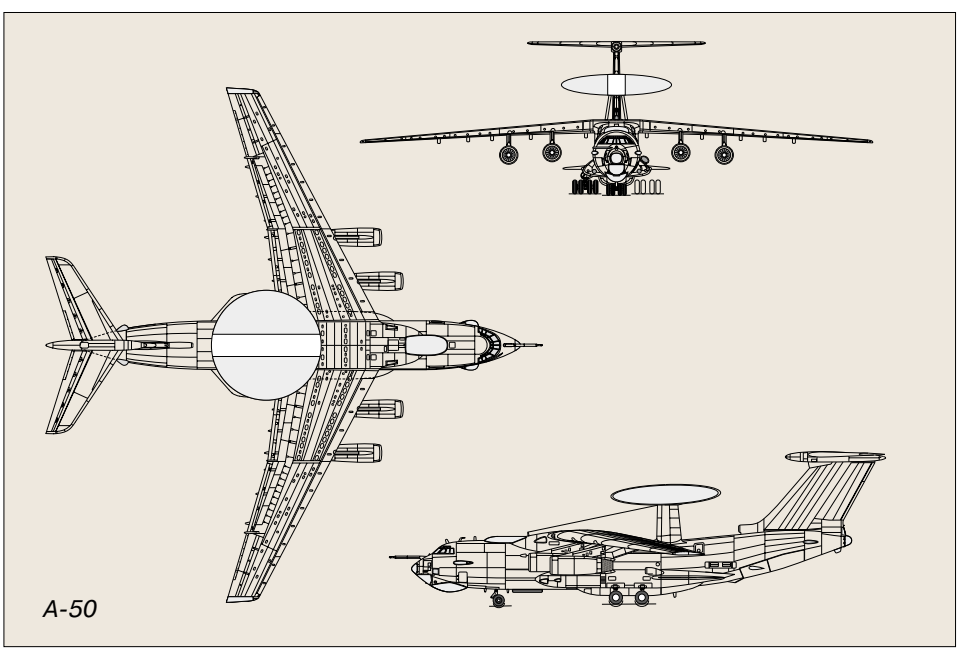
Instead of the A-50M the Russian Air Force decided to develop a cheaper A-50U AWACS alternative with the advanced Shmel-M radar system providing a two-fold increase in the number of tracked targets and guided fighters, and boasting a greater detection range. A mock-up of an aircraft like that was built in 1990, while in 1993 a production A-50 started to be converted into a prototype of the new AWACS aircraft. The A-50U was expected to have commenced flight tests in 1995 with subsequent retrofitting of operational A-50s to its level. However, due to insufficient funding, development of the advanced radar system has so far failed to reach the flight tests stage.

The project, aimed at developing A-50 export versions for potential foreign customers, has seen greater progress. India was the first to express its interest in the AWACS aircraft, based on the A-50, as far back as 1988 (for more details see the main review of the present issue). Russia and Israel secured the first contract on joint development of the A-50I AWACS aircraft, to be fielded with China, at the Le Bourget air show on 17 June 1997. Under the contract, signed by the Rosvoorouzhenie State Enterprise (now Rosoboronexport) and Beriev company and the Israel Aircraft Industries (IAI), Beriev was tasked with developing a platform to be fitted with the Israeli-produced radar system.

Ye.P.Konstantinov was appointed chief designer of the A-50I project (product AI, where "I" stands for Israeli) at Beriev company. The aircraft was based on the production A-50, stripped of Russian avionics and upgraded to mount the EL/M-205 Phalcon radar (where Phalcon stands for Phased Array L-band Conformal Radar), developed by Elta Electronics, affiliate office of the IAI.

In the course of converting the A-50 into the A-50I the following modifications were introduced:

- the aircraft was fitted with the fixed mushroom-shaped radome with a diameter of 11.5m (the A-50 features a rotating radome with a diameter of 10.8m, while the US E-3A features a radome with a diameter of 9.1m), and pylons for the new radome; the radome design envisions housing three EL/M-205 Phalcon radar phased arrays, forming a triangle;
- the fuselage design was improved;
- the operators' cockpit and the rest room were quartered in the pressurised part of the fuselage; the aircraft was equipped with racks for housing the Phalcon radar units, operators' workstations and resting places;



A-50

Beriev/IAI A-50I prototype in a test flight. Note a bigger non-rotating radome with a phased array "triangle"

- the aircraft was modified to accommodate a five-man strong flying crew, ten avionics operators, and nine by-crew members;

- the aircraft was fitted with an emergency hatch for the operators to bail out;

- the rear fuselage design was improved and ventral fins were mounted to provide the aircraft with the directional stability;

- the airframe mounted 71 antennae, including 44 aerials of the Phalcon system;

- the nose and the rear fuselage, as well as wingtips were modified to quarter antennae of the electronic systems;

- electric power, liquid- and air-cooling, air-conditioning, oxygen supply, communications, and other systems were modified.

The A-50 was converted into the A-50I in 1997-99, and on 28 July 1999 a flight crew headed by test pilot Gennady Kalyuzhny took the aircraft for its maiden flight off the factory airfield in Taganrog.

A total of 15 test flights and seven training flights had been carried out during the tests. The tests conducted proved that the aircraft met all the requirements, specified by the customer, and on 26 October 1999 the A-50I, which had received civilian registration number RA-78740 (later on changed to 4X-AGI), was ferry-flown to Israel to be fitted with the radar system and tested.

A total of four aircraft were to have been fielded with the Chinese Air Force, but in summer 2000 under a most powerful political pressure from the USA the Israeli government suspended the contract. In 2001 new Israeli prime-minister Ariel Sharon officially informed China of the contract's being reneged on. While the only A-50I built is still in Israel, parked in a fenced-off area of the capital's Ben Gurion airport, where it can now be seen by passengers of airliners, making final approaches over Tel Aviv.

Given the renewed interest in the AWACS aircraft, based on the A-50, expressed by India, as well as unfulfilled Chinese needs due to the A-50I project's termination, Beriev and MNIIP embarked on developing the new export version of the AWACS aircraft, designated A-50E (where "E" stands for export) at the turn of the century. Depending on the customer's requirements, the aircraft may be fitted with both the Russian Shmel radar system, developed by MNIIP, and the Israeli Phalcon radar. The A-50E aircraft are supposed to be built by TAPC (Uzbekistan) with the assistance of Beriev (Russia) according to production forms and records, developed by the Ilyushin Aviation Association, with the new AWACS aircraft based on the series production Il-76TD, fitted with more sophisticated and powerful PS-90A engines. The A-50EI version, being offered to India, envisages fitting the aircraft with the Israeli Phalcon radar system, but part of the avionics suite is being developed by the Russian MNIIP institute. The contract on developing and delivering to India several A-50EI aircraft may be secured as early as 2003. In addition to that, the new A-50E version may be offered to China once again. Other traditional foreign importers of Russian aircraft are also expressing their interest in this aircraft.

Development of AWACS aircraft in the USSR and later in Russia was by no means limited only to the Tu-126 and the A-50 strategic aircraft, and versions of the latter. In order to facilitate efficient combat operations of naval fighter aviation, deployed on project 1143.5 heavy aircraft carriers and those of further projects, the Kamov Company and the Nizhny Novgorod Radio Engineering Research Institute (NIIRT) embarked on developing a shipborne AEW helicopter with the Oko radar system, based on the Ka-252TB (Ka-29) helicopter, designated Ka-252RLD, and later on Ka-31, as far back as the late 1970s. In 1979 the Yakovlev Design Bureau started to develop the shipborne Yak-44 AWACS aircraft to provide air defence to CVBGs. In 1982 the Kiev-based Antonov Design Bureau was tasked with designing the An-71 theatre AWACS aircraft, based on the An-72 transport and fitted with the Kvant radar, developed by MNIIP. In addition to that, other design bureaux also tried to come up with their own versions of light AWACS aircraft (based primarily on multirole shipborne and future transport aircraft). Of all these projects only the Ka-31 has managed to progress through the whole set of tests, and enter the inventory, and the series production in 1998 (it also made way to foreign states). The An-71 project, which underwent flight tests in 1985-1990, had been suspended shortly before the USSR broke up, but this AWACS aircraft may still stand a chance of being fielded. Air Fleet plans to dwell on these AWACS systems in its coming issues.

Vladimir RIGMANT,
Viktor ANDREYEV

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INTERVESTNIK
PUBLISHING HOUSE

P.O.Box 77, Moscow, 125057, Russia
Tel: +7 (095) 158 3305, 158 9501

Fax: +7 (095) 956 0107
E-mail: af@airfleet.ru

Komsomolsk-on-Amur Aircraft Production Association (KnAAPO) JSC

1, Sovetskaya st.,
Komsomolsk-on-Amur, 681018, Russia
Phone: +7(42172) 2-98-77, 7-65-89
Fax: +7(42172) 2-98-77, 7-64-51, 2-98-51
E-mail: knaapo@kmscom.ru